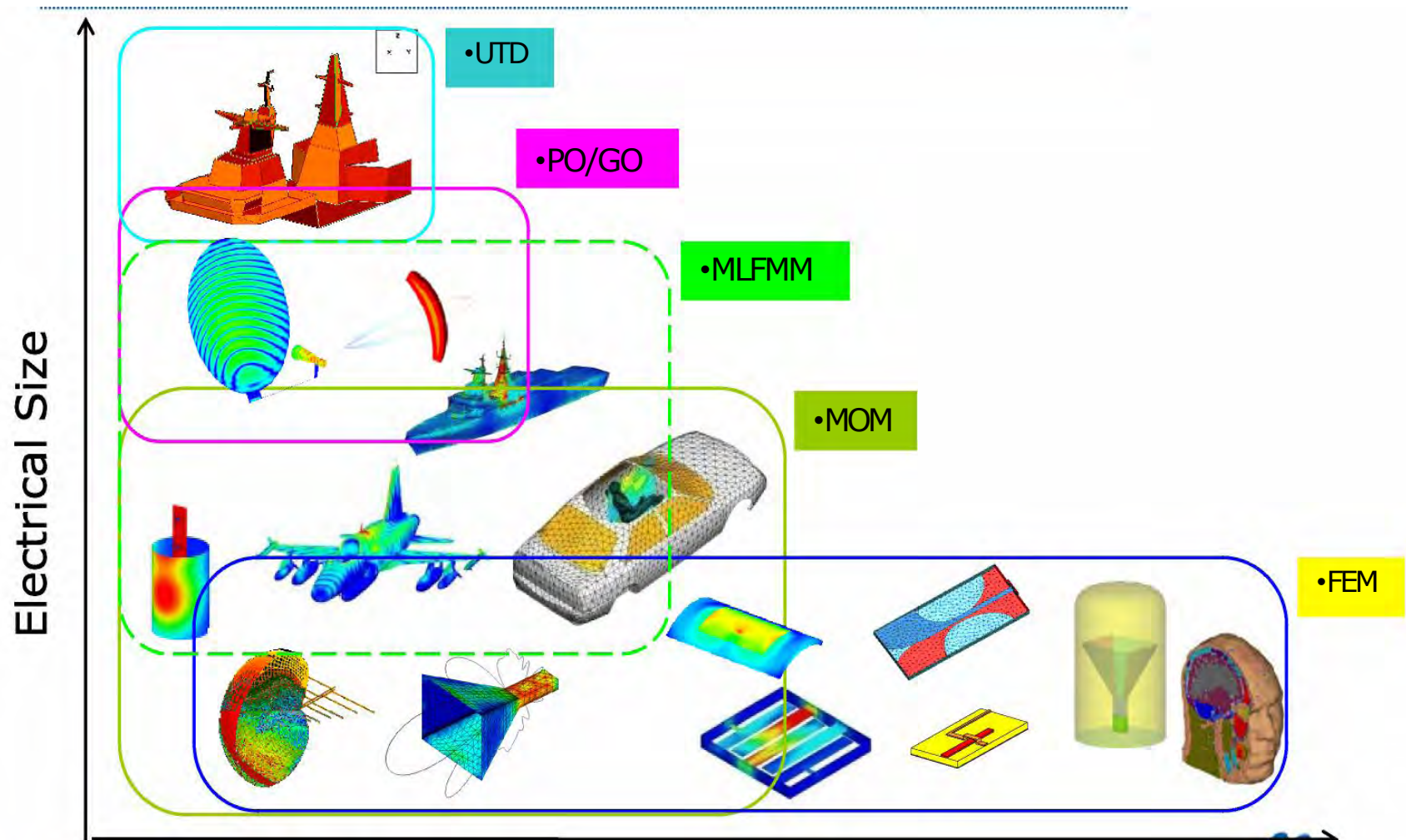


Pacificon Presentation
Using FEKO to Calculate Antenna
Patterns on Vehicles
October 10, 2014

Keith Snyder
KI6BDR

email: snyder_kas@mindspring.com

3D EM Simulation Map



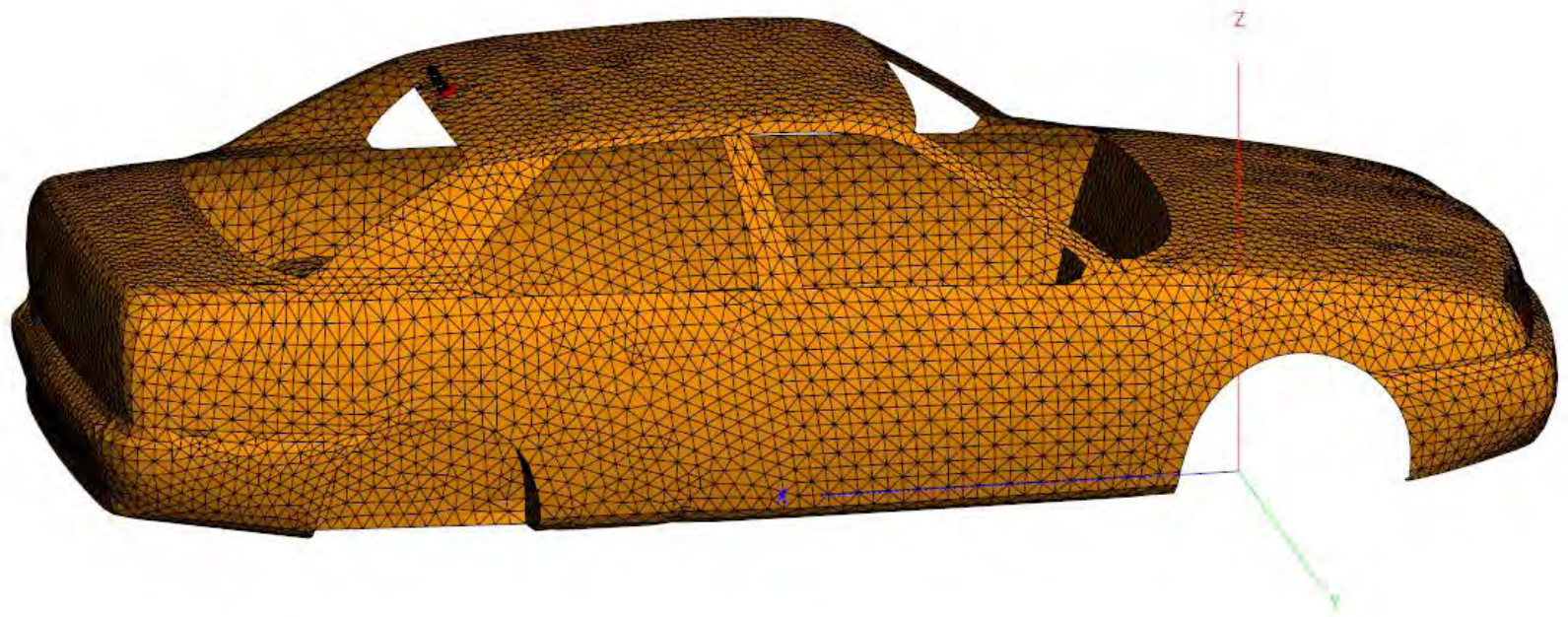
Ulrich Jakobis – New ACES Fellow

Author of the FEKO Code



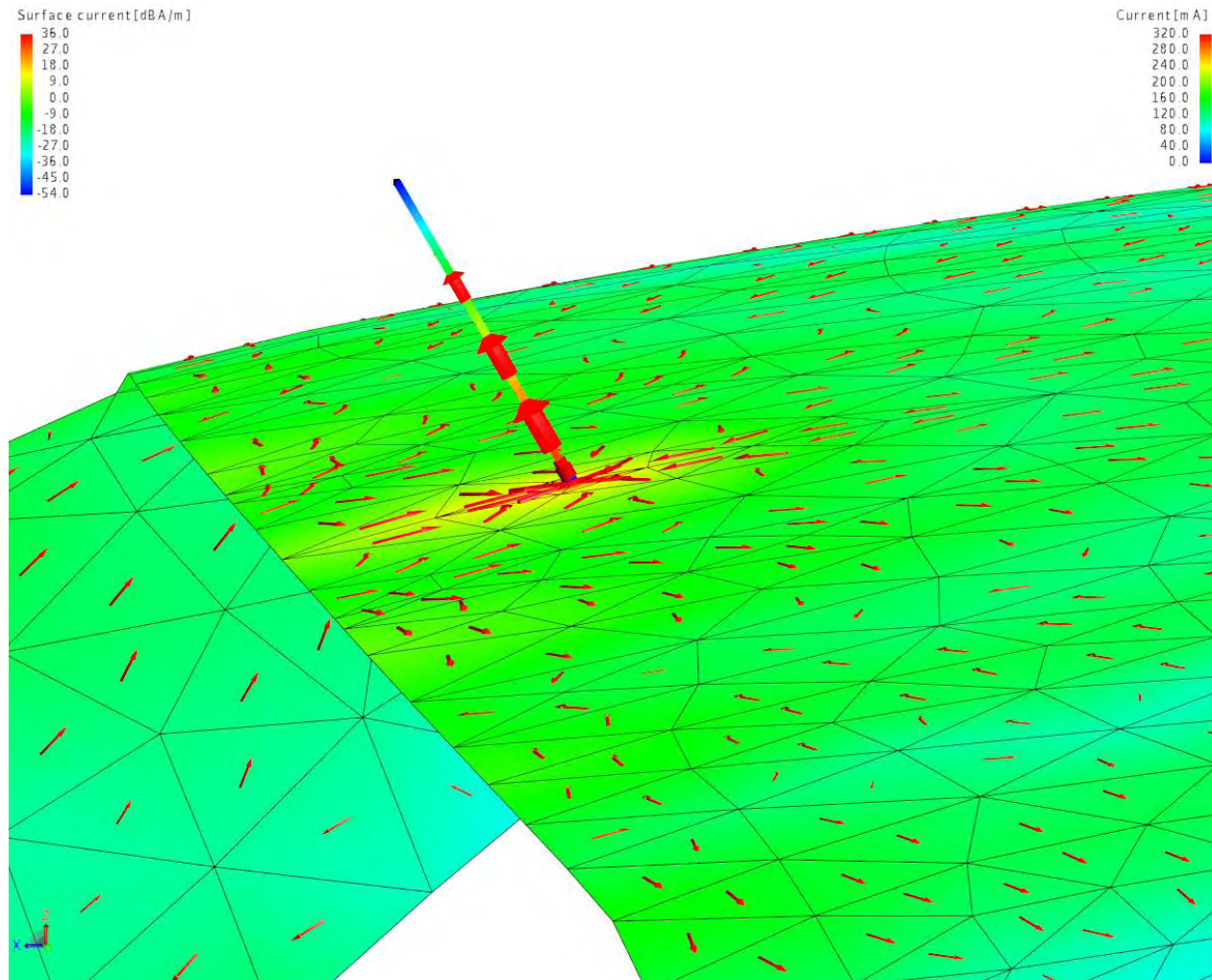
FEKO WEBSITE: <http://www.feko.info/>

Generic Car Made of Triangles with Wire Antenna

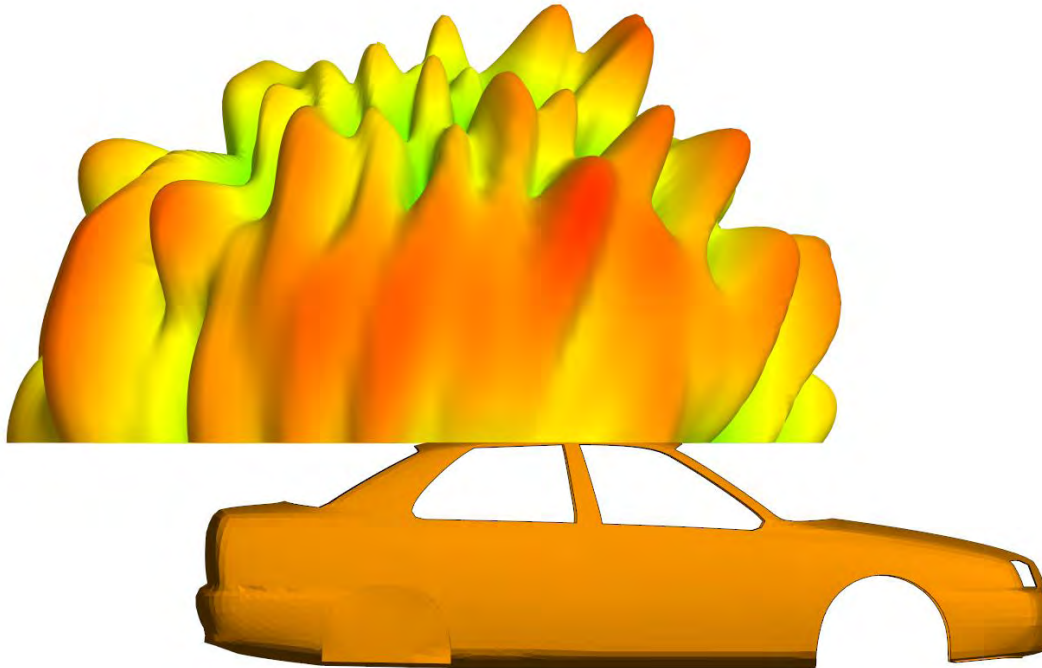
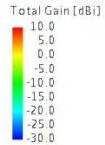


Number of Triangles = 20,434

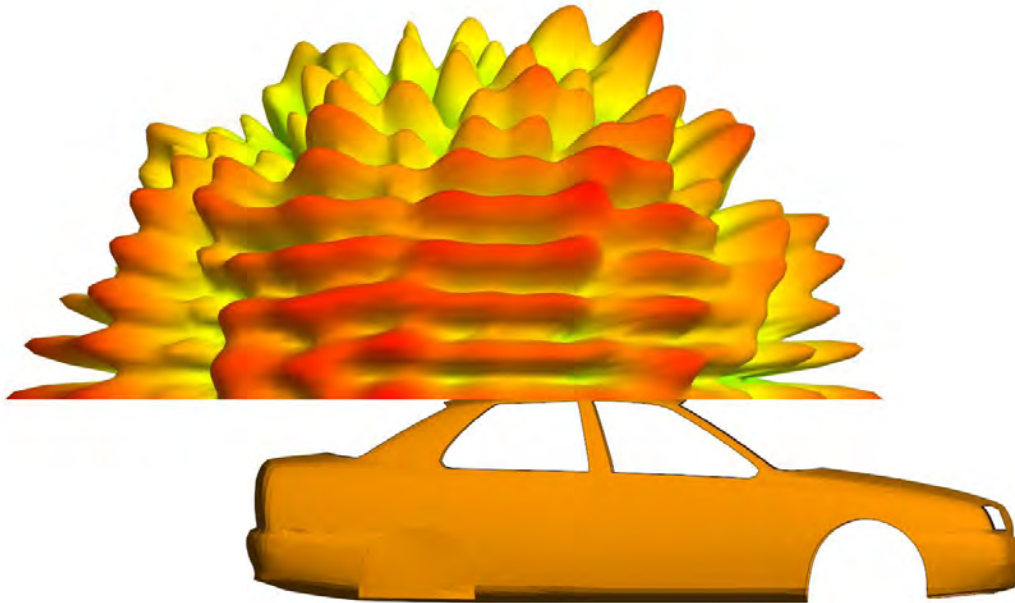
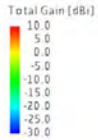
FEKO Solves for Currents on the Wires as well as the Surface Triangles



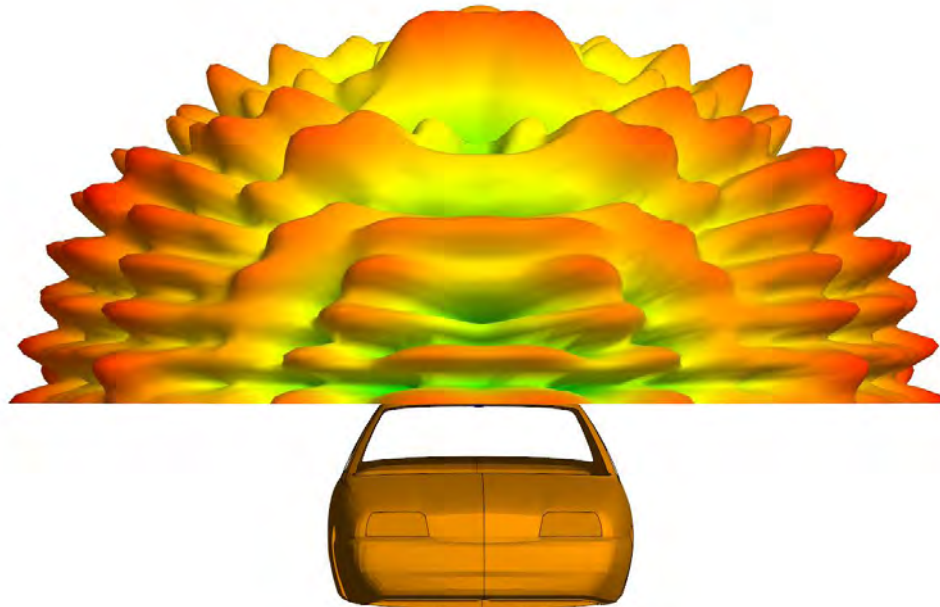
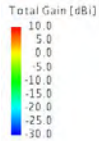
Generic Car Antenna Pattern 900 MHz (no Ground Plane)



Generic Car Antenna Pattern 900 MHz With Perfect Conducting Ground

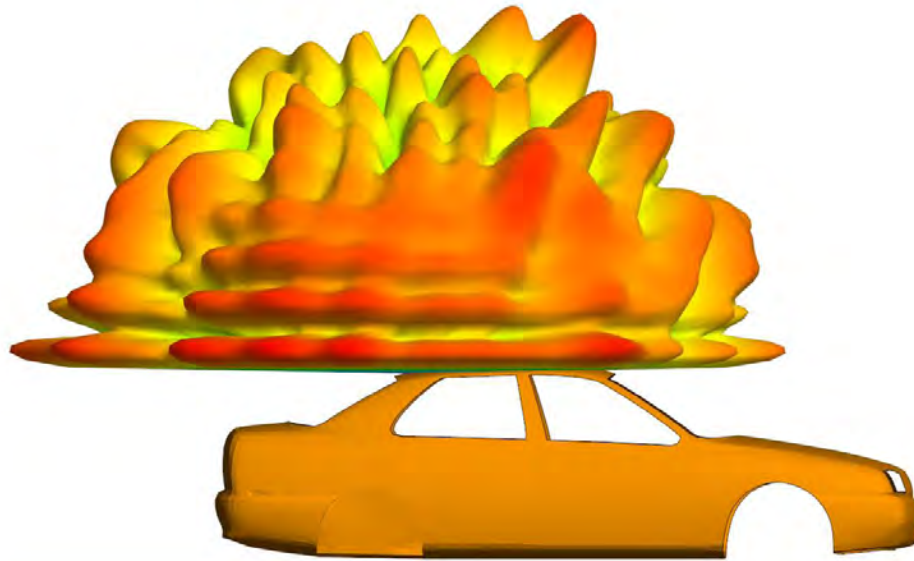


Generic Car Antenna Pattern 900 MHz With Perfect Conducting Ground



Generic Car Antenna Pattern 900 MHz With Earth Ground

Total Gain [dBi]
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0

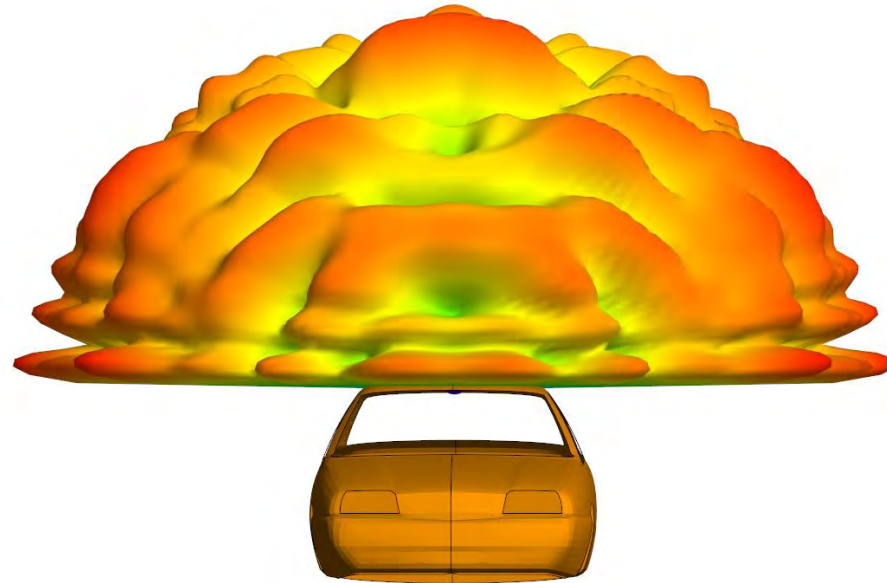
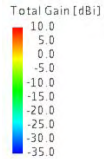


$\epsilon_r=5$

$\sigma=.005 \text{ S/m}$



Generic Car Antenna Pattern 900 MHz With Earth Ground

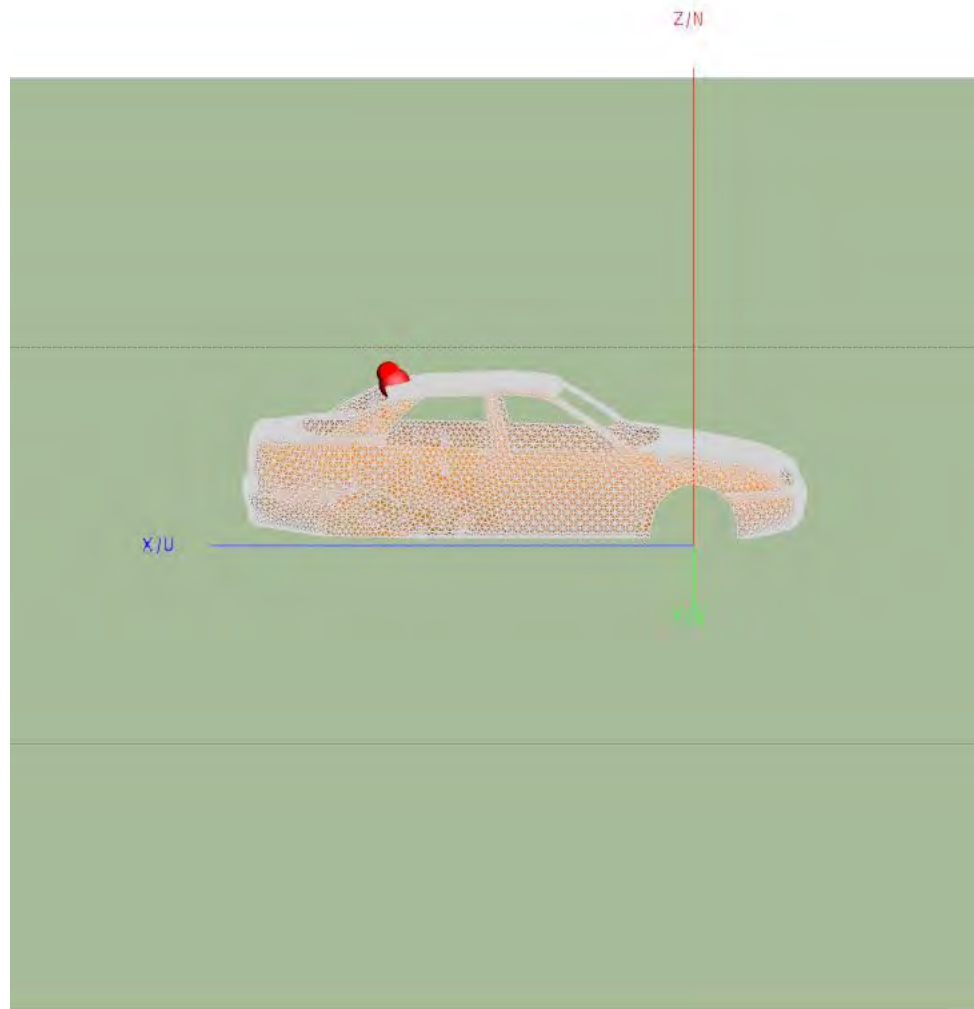


$\epsilon_r=5$

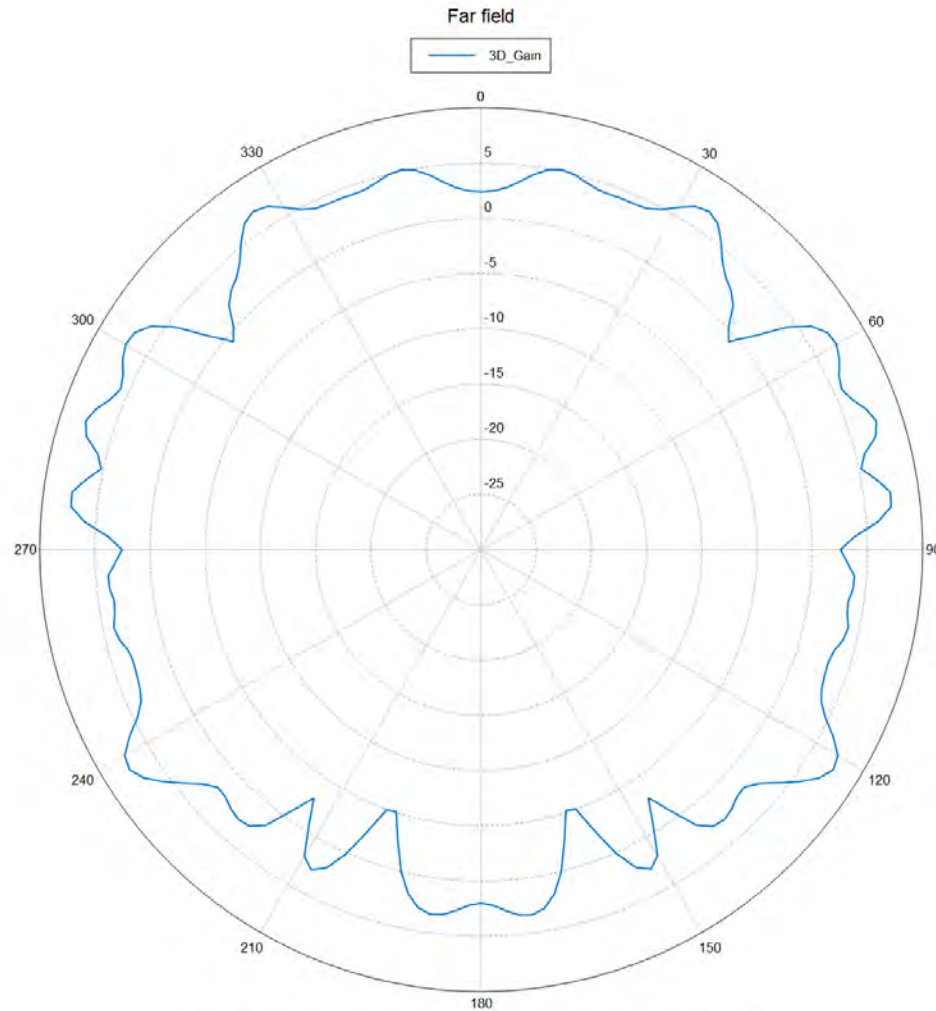
$\sigma=.005 \text{ S/m}$



Antenna Co-Ordinate System



Generic Car Antenna Pattern 900 MHz With Earth Ground 5 Degree Elevation

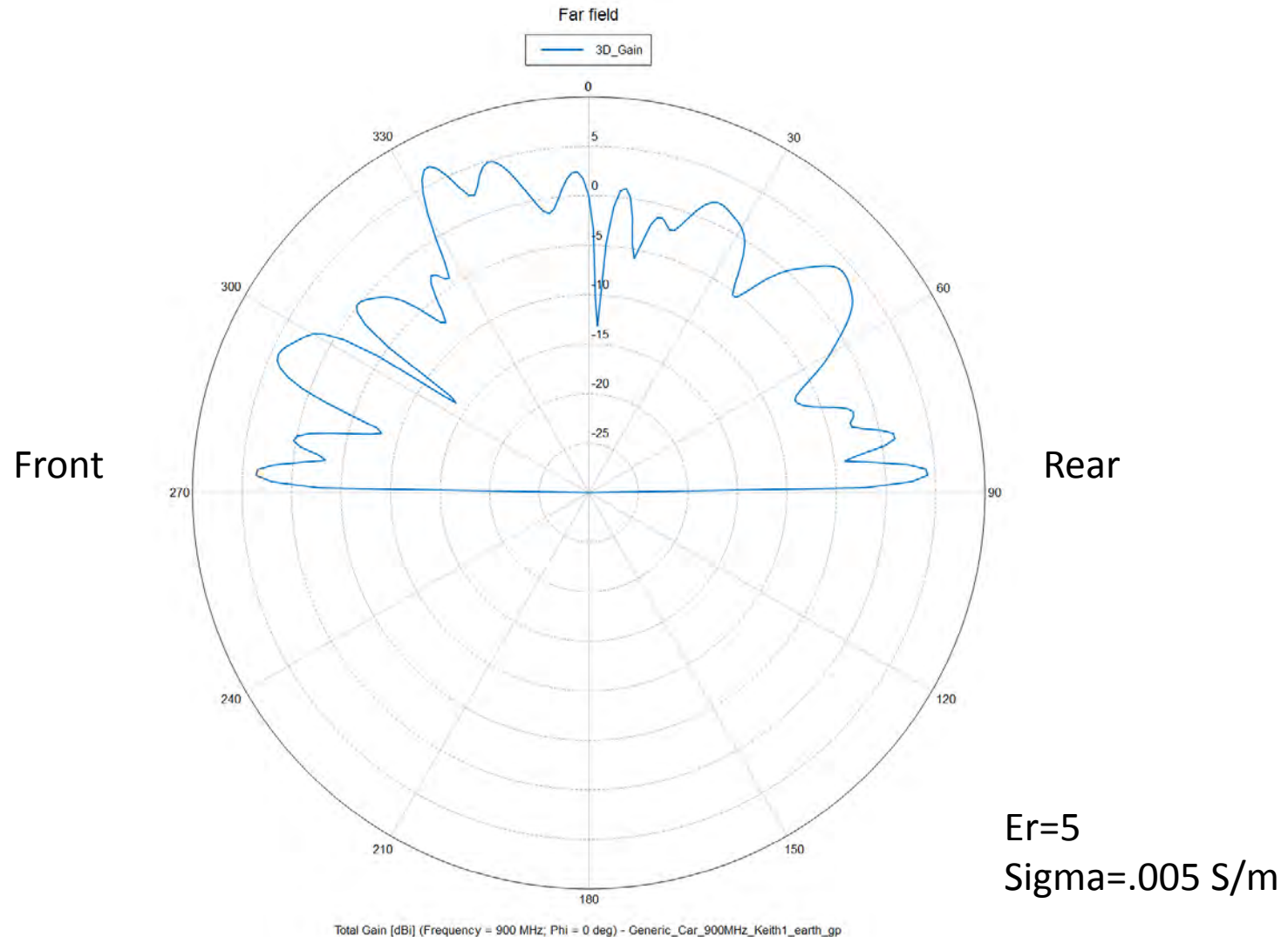


Total Gain [dBi] (Frequency = 900 MHz; Theta = 85 deg) - Generic_Car_900MHz_Keith1_earth_gp

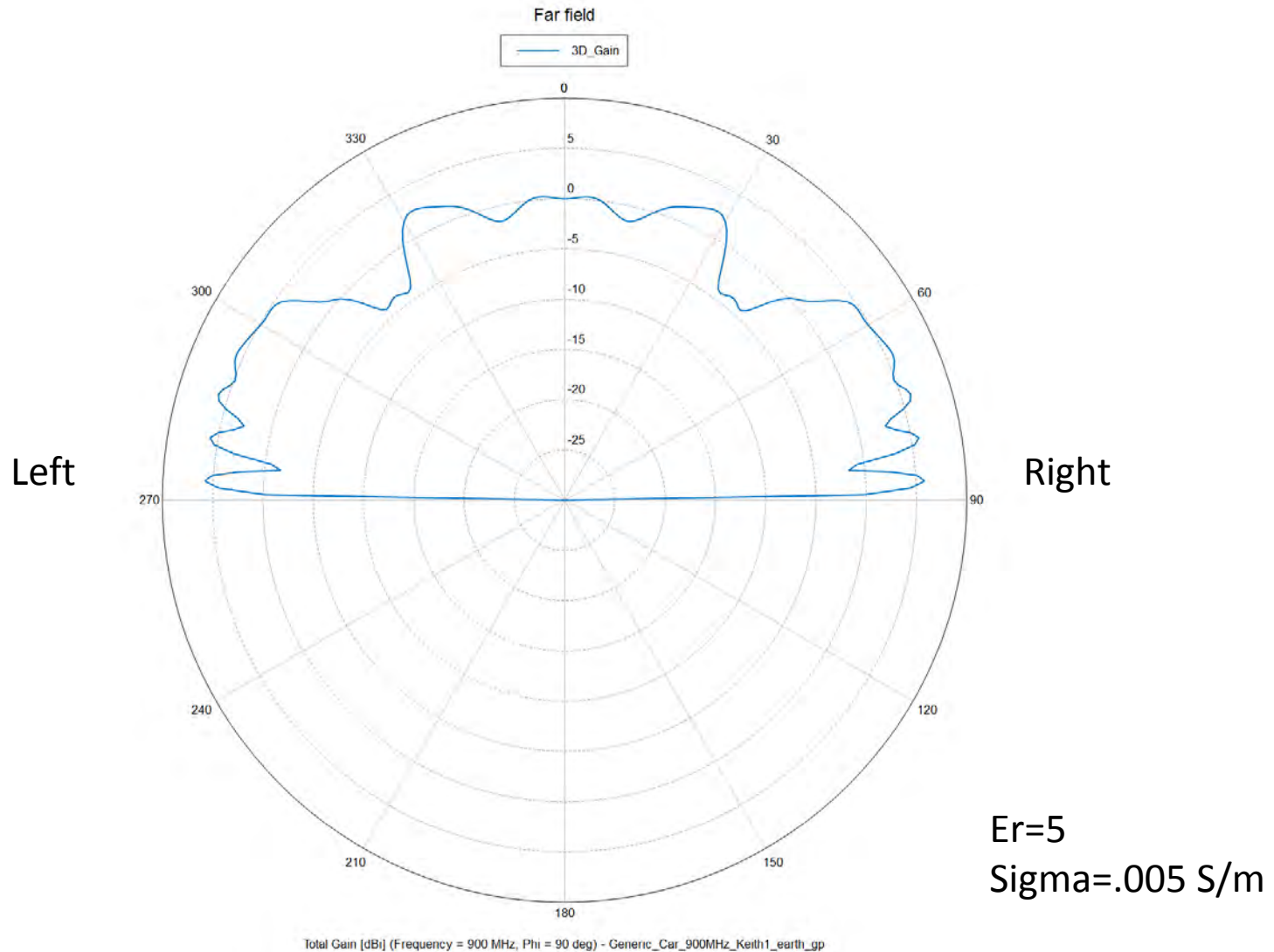
Front

Er=5
Sigma=.005 S/m

Generic Car Antenna Pattern 900 MHz With Earth Ground Elevation Pattern

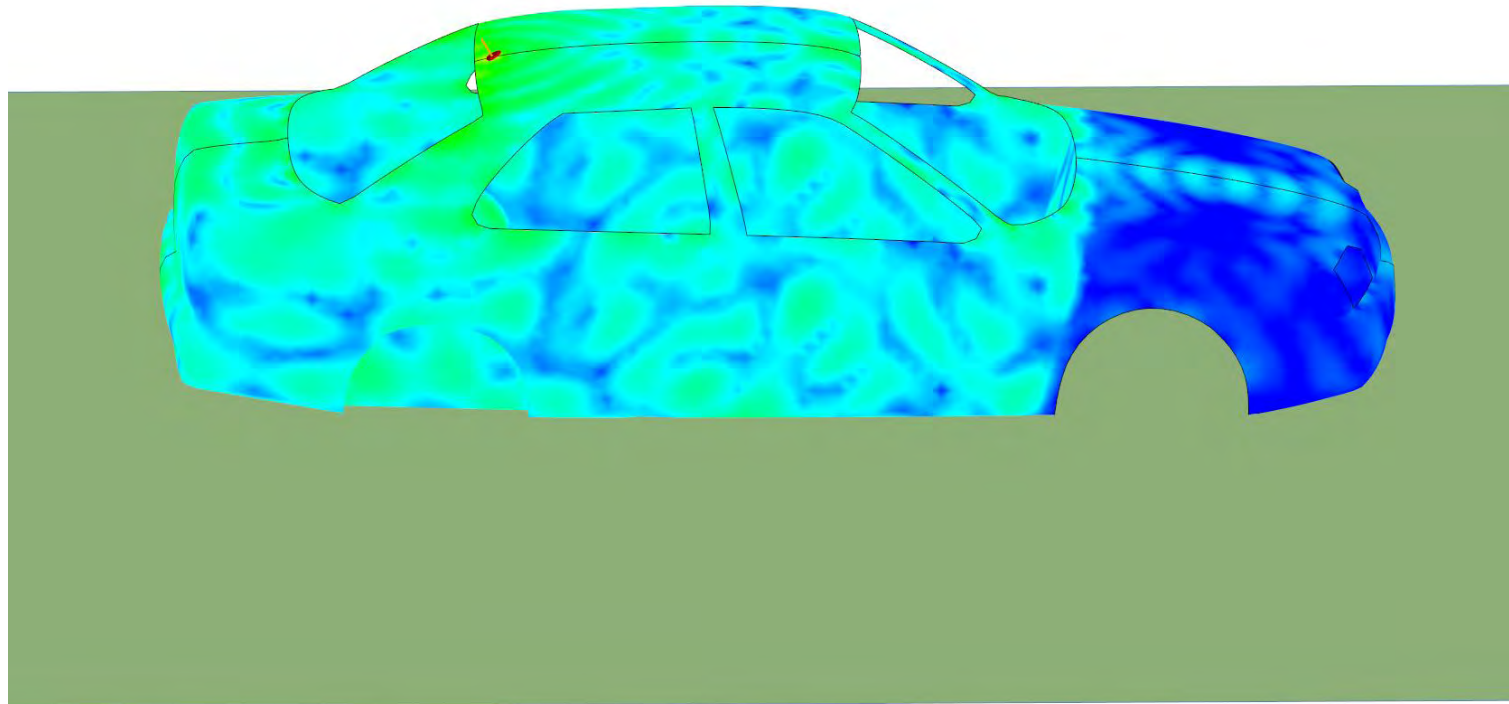
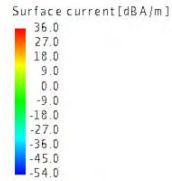


Generic Car Antenna Pattern 900 MHz With Earth Ground Elevation Pattern

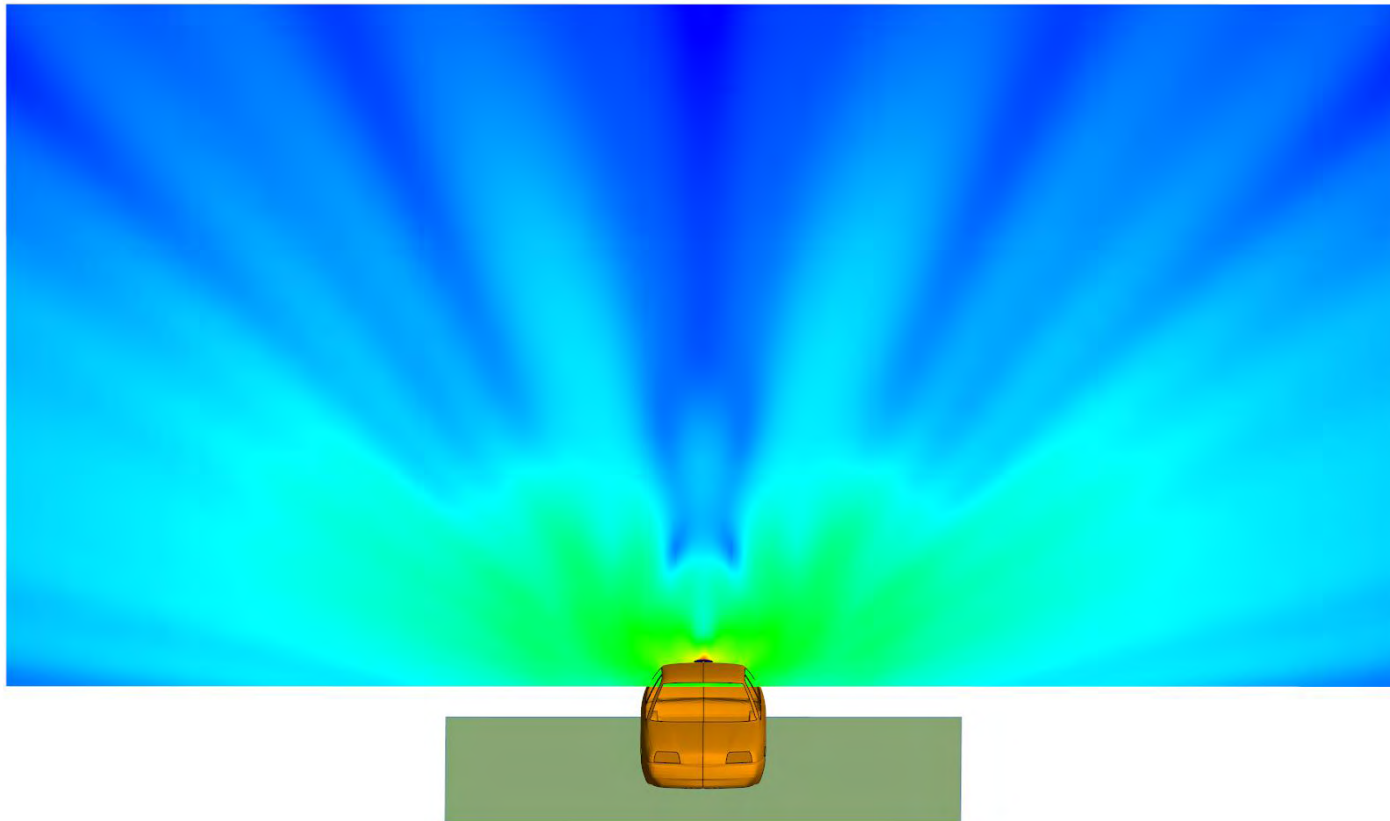
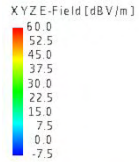


Currents on the Skin of the Generic Car

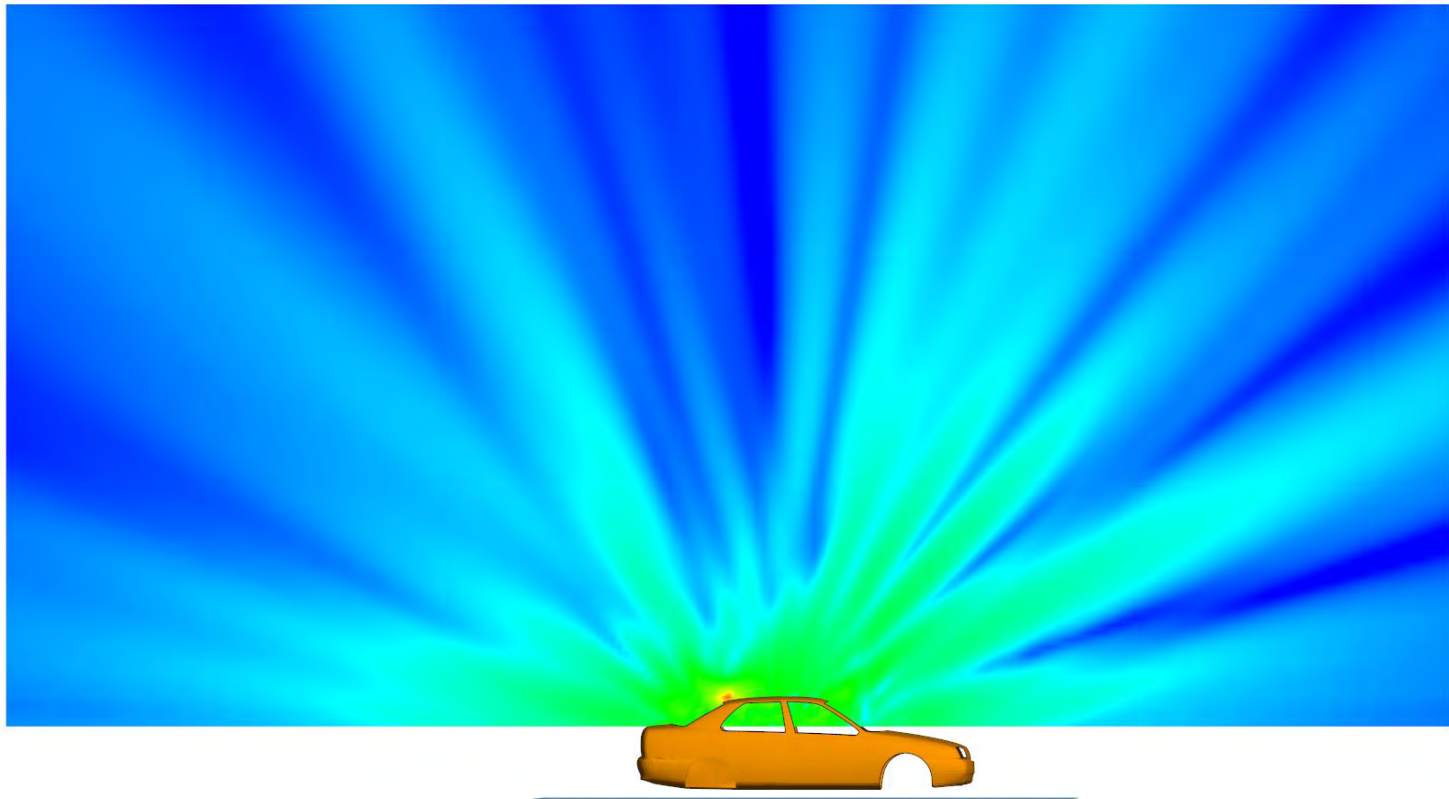
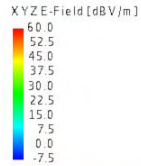
900 MHz P=2 Watts



Near Fields with 2 Watts Applied



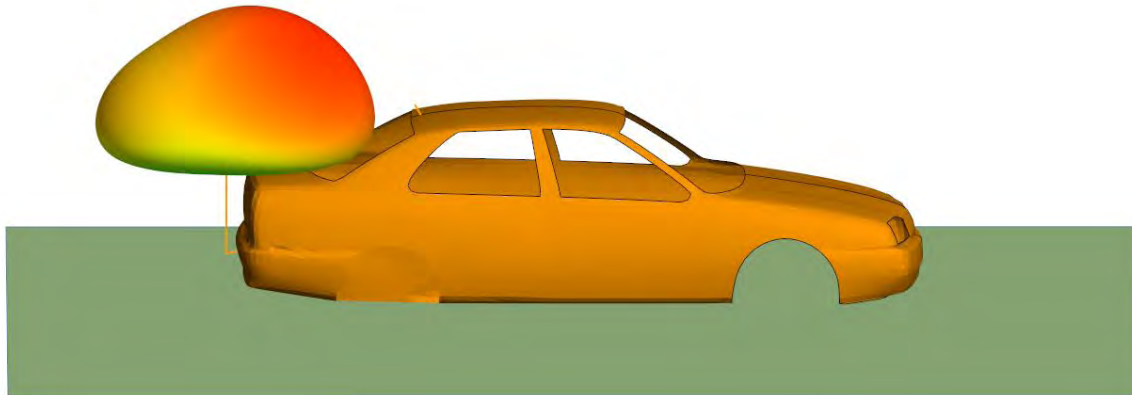
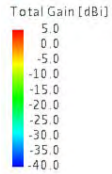
Near Fields with 2 Watts Applied



What about on the Rear Bumper?

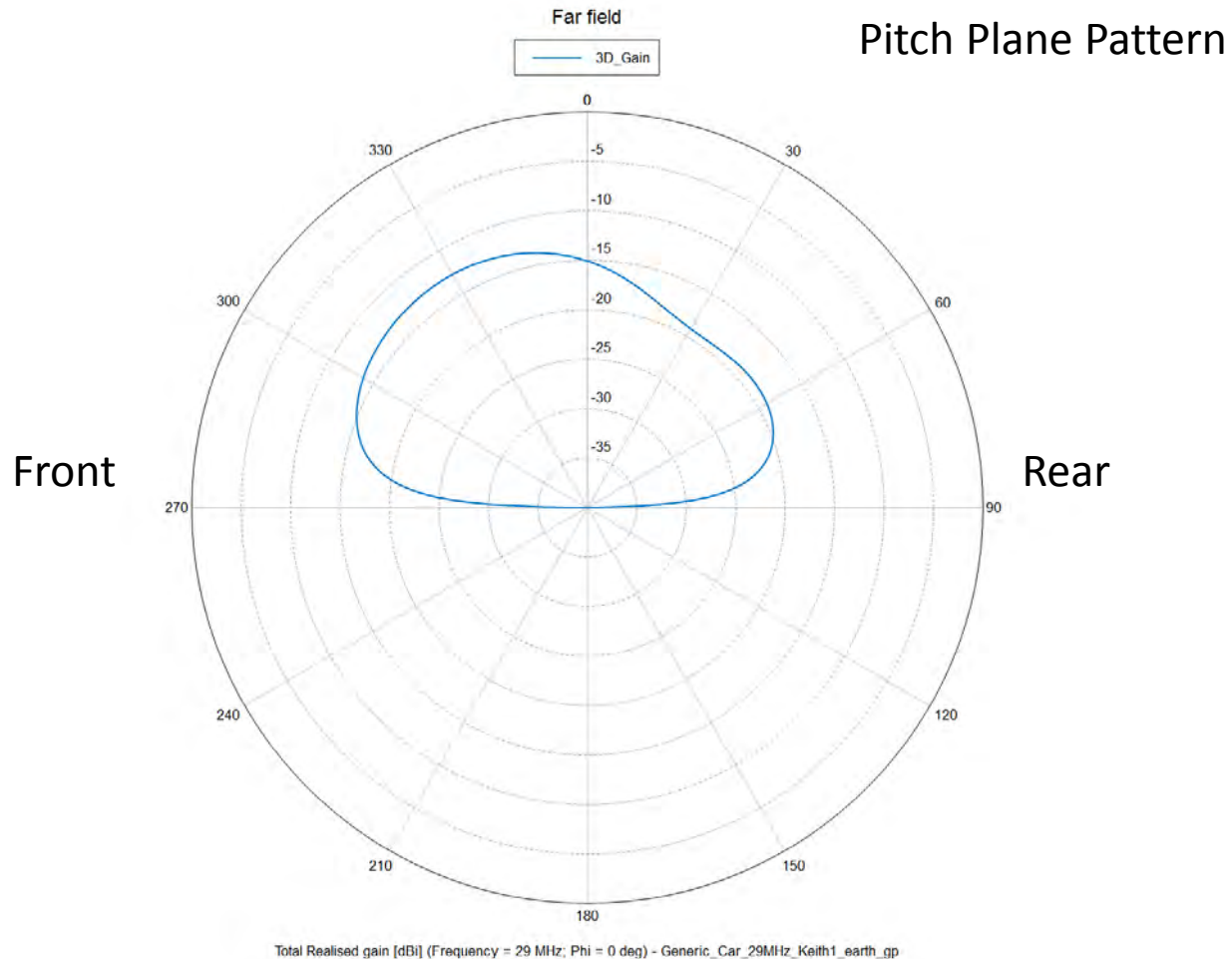


29 MHz on Rear (Earth Ground) Far Field Pattern (Directivity)



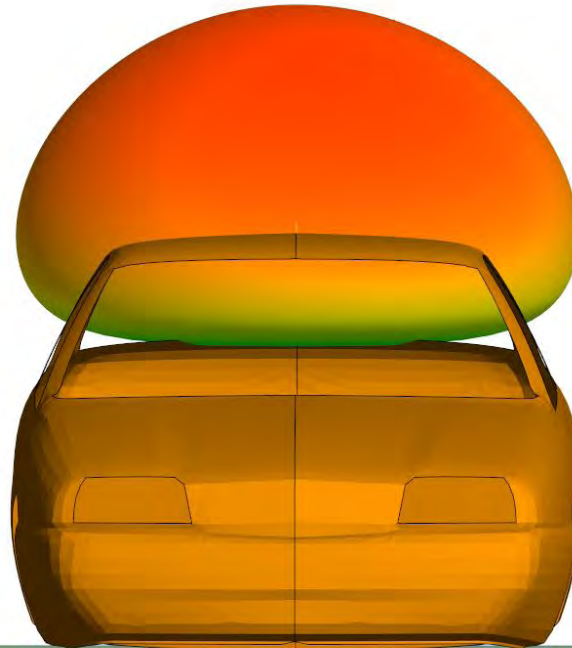
29 MHz on Rear (Earth Ground)

Far Field Pattern Realized Gain



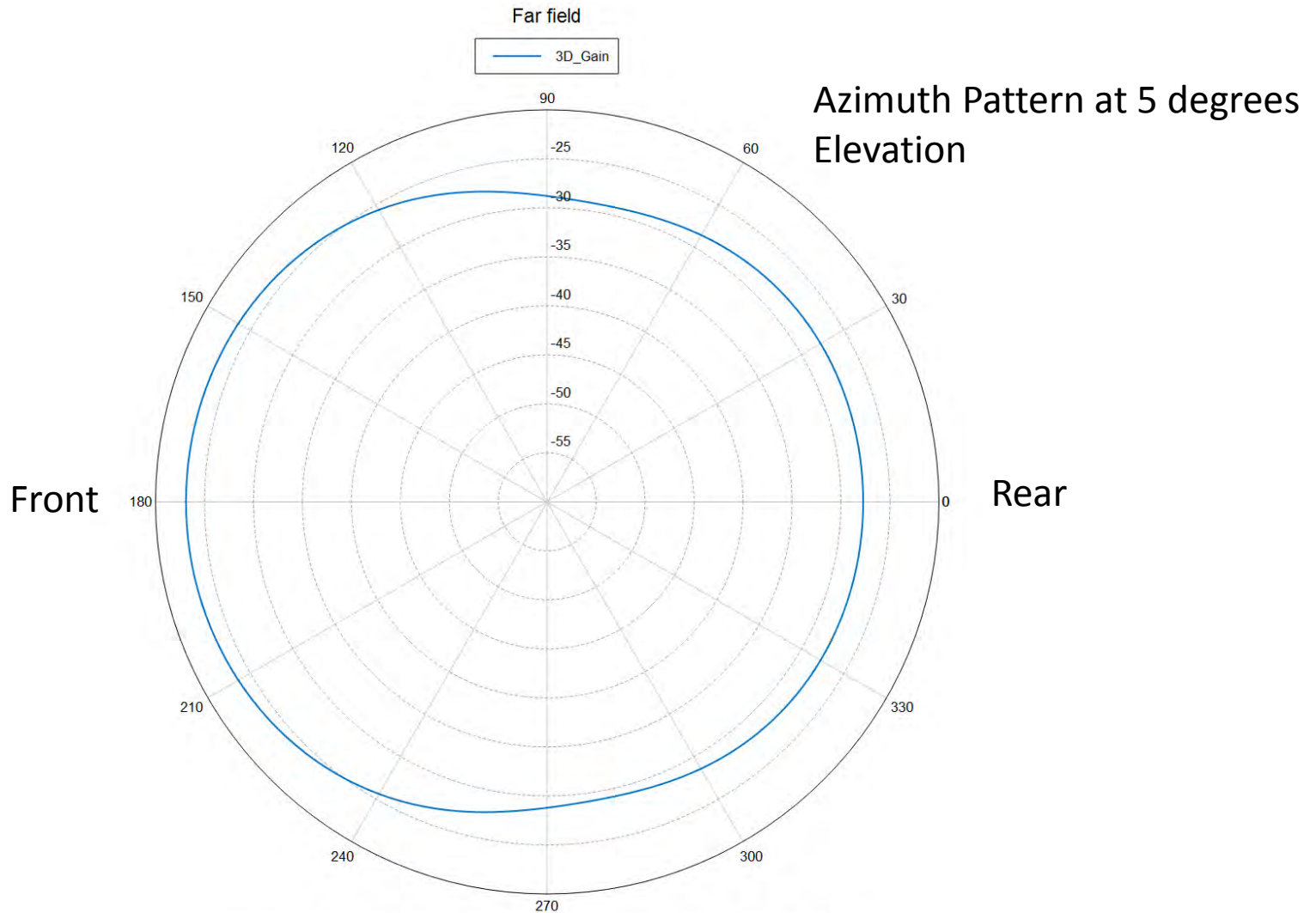
29 MHz on Rear (Earth Ground) Far Field Pattern Realized Gain

Total Realised gain [dBi]
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-45.0
-50.0
-55.0



29 MHz on Rear (Earth Ground)

Far Field Pattern Realized Gain

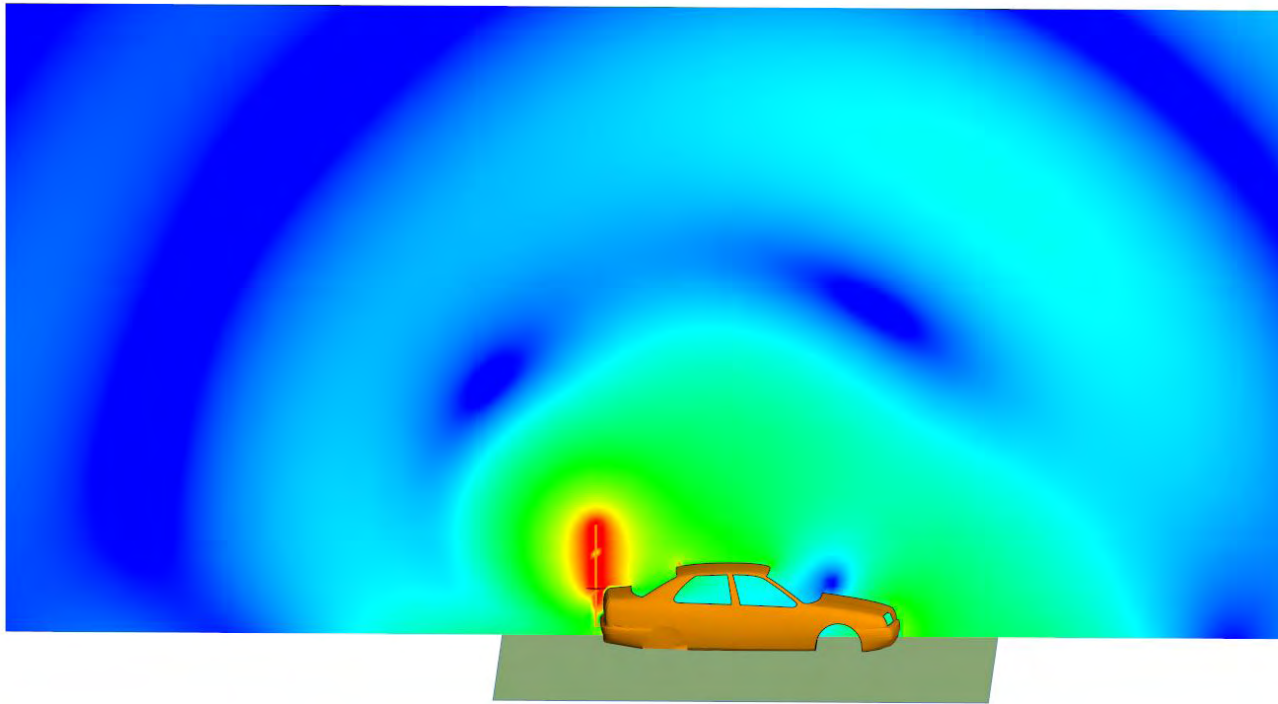


Total Realised gain [dBi] (Frequency = 29 MHz; Theta = 85 deg) - Generic_Car_29MHz_Keith1_earth_gp

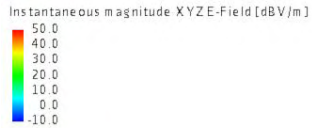
29 MHz on Rear (Earth Ground) Near Field Pattern

Instantaneous magnitude XYZ E-Field [dBV/m]
50.0
40.0
30.0
20.0
10.0
0.0
-10.0

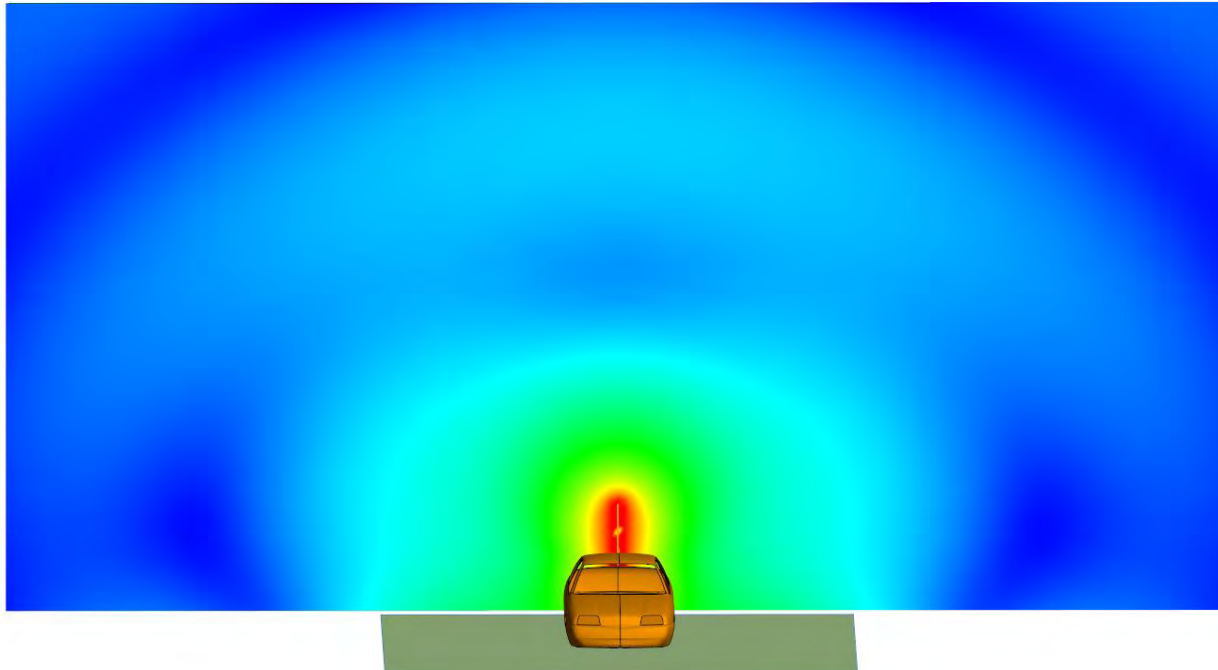
2 Watts Excitation



29 MHz on Rear (Earth Ground) Near Field Pattern



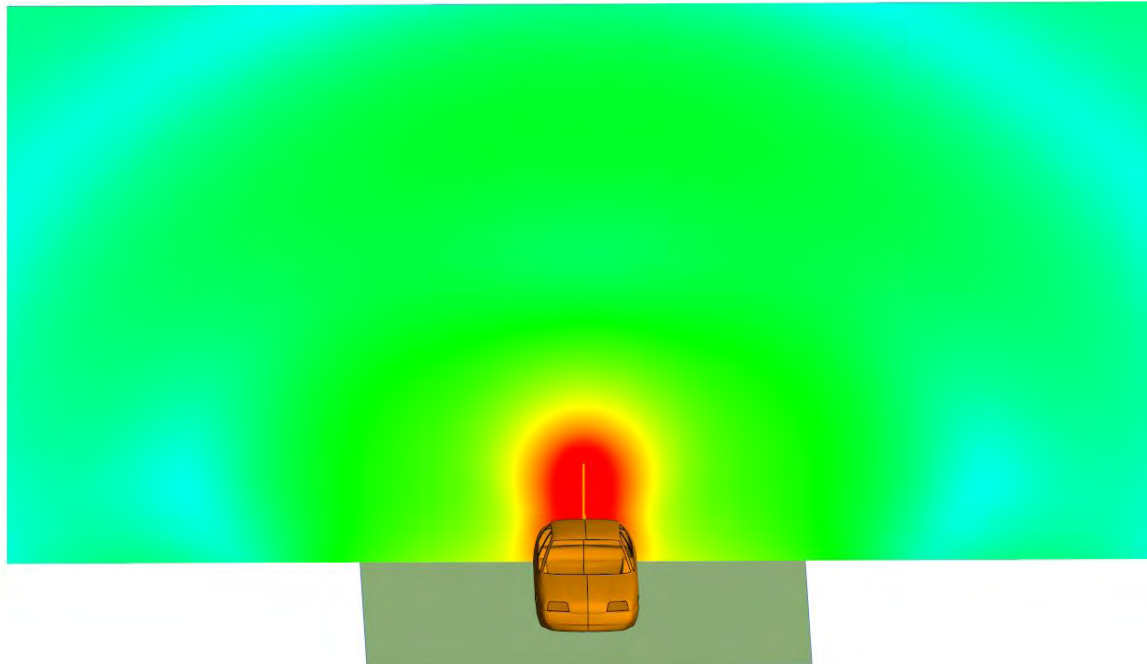
2 Watts Excitation



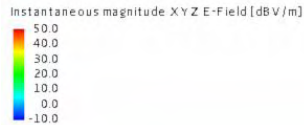
29 MHz on Rear (Earth Ground) Near Field Pattern

Instantaneous magnitude XYZ-Field [dBV/m]
50.0
40.0
30.0
20.0
10.0
0.0
-10.0

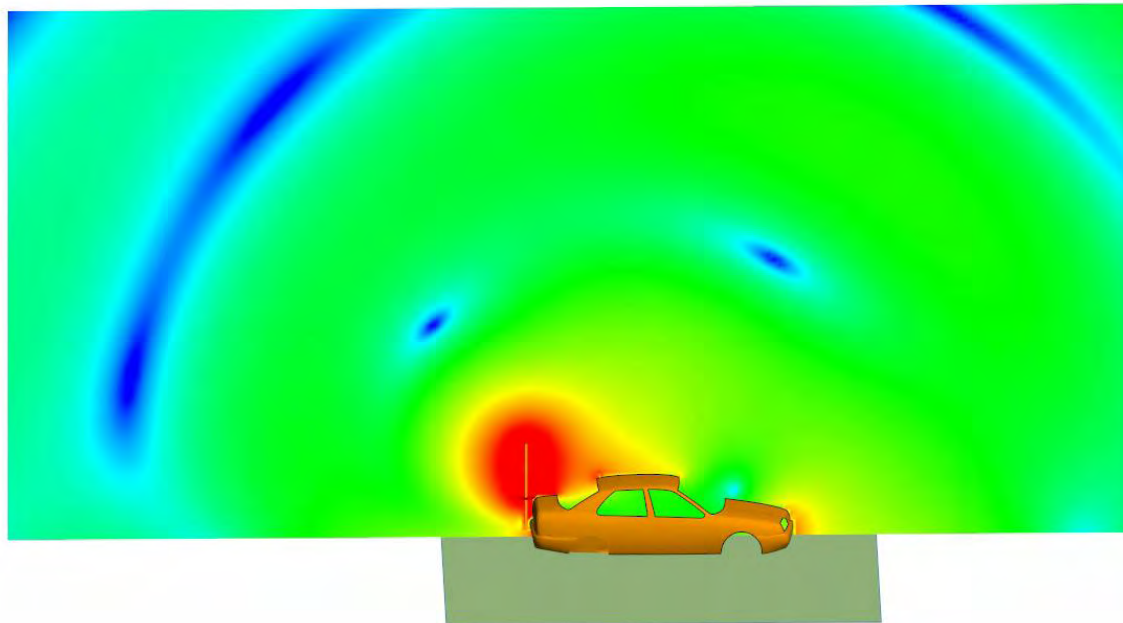
75 Watts Excitation



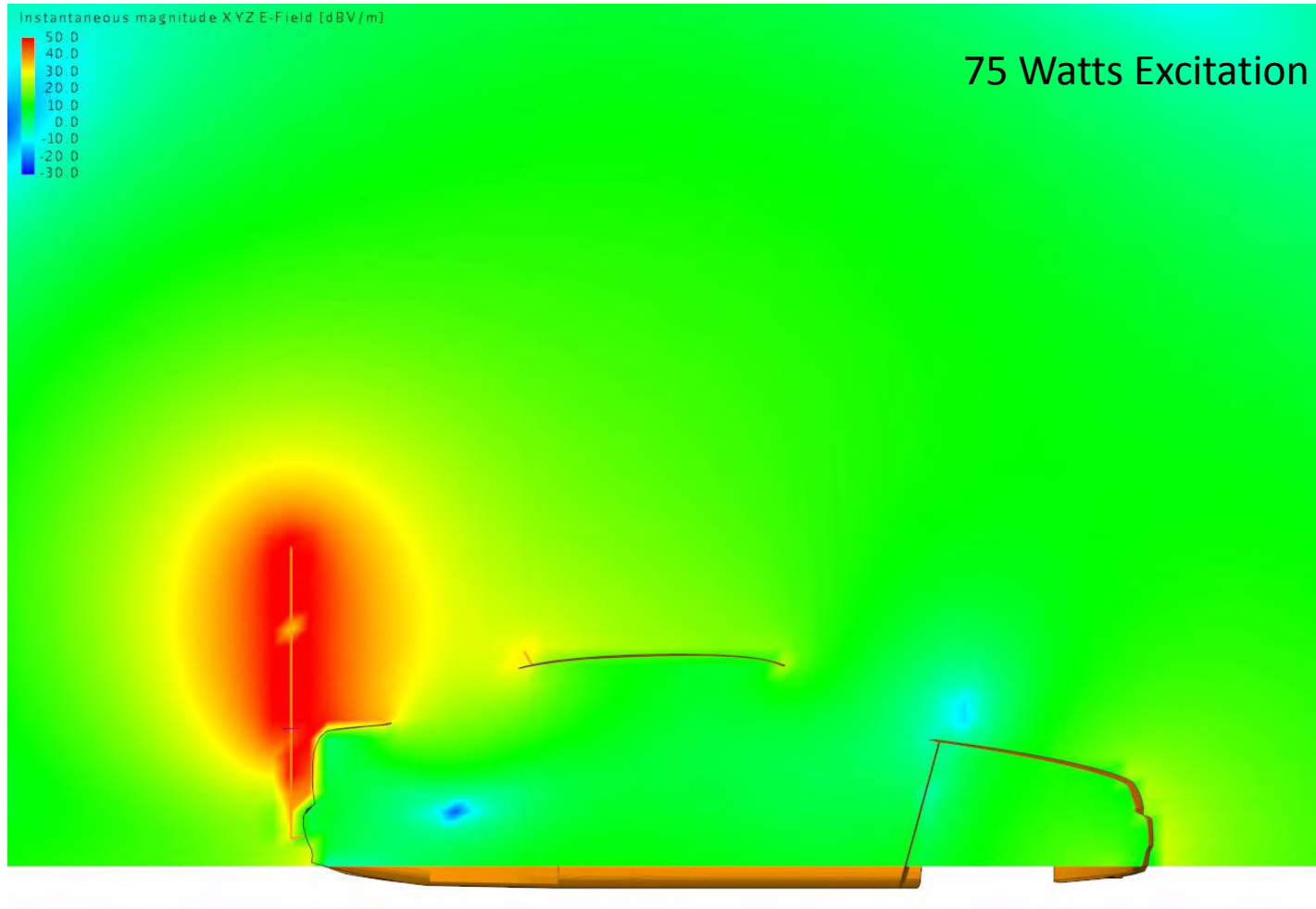
29 MHz on Rear (Earth Ground) Near Field Pattern



75 Watts Excitation

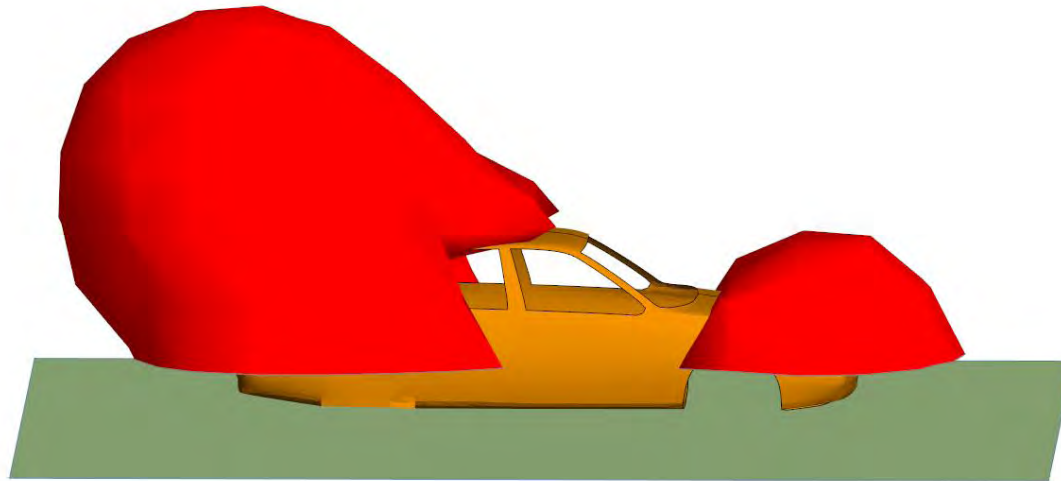


29 MHz on Rear (Earth Ground) Near Fields in the Car



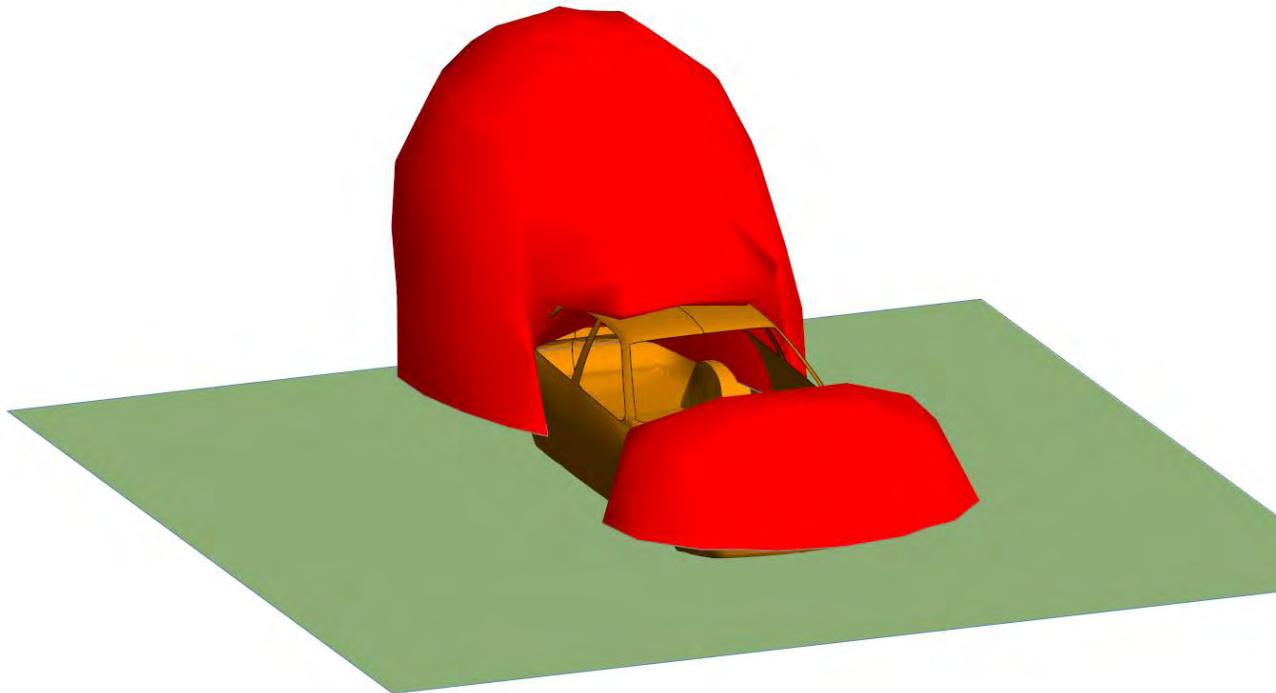
29 MHz on Rear (Earth Ground) Radiation Hazard Calculation 61.4 V/m

75 Watts Excitation

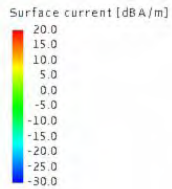


29 MHz on Rear (Earth Ground) Radiation Hazard Calculation 61.4 V/m

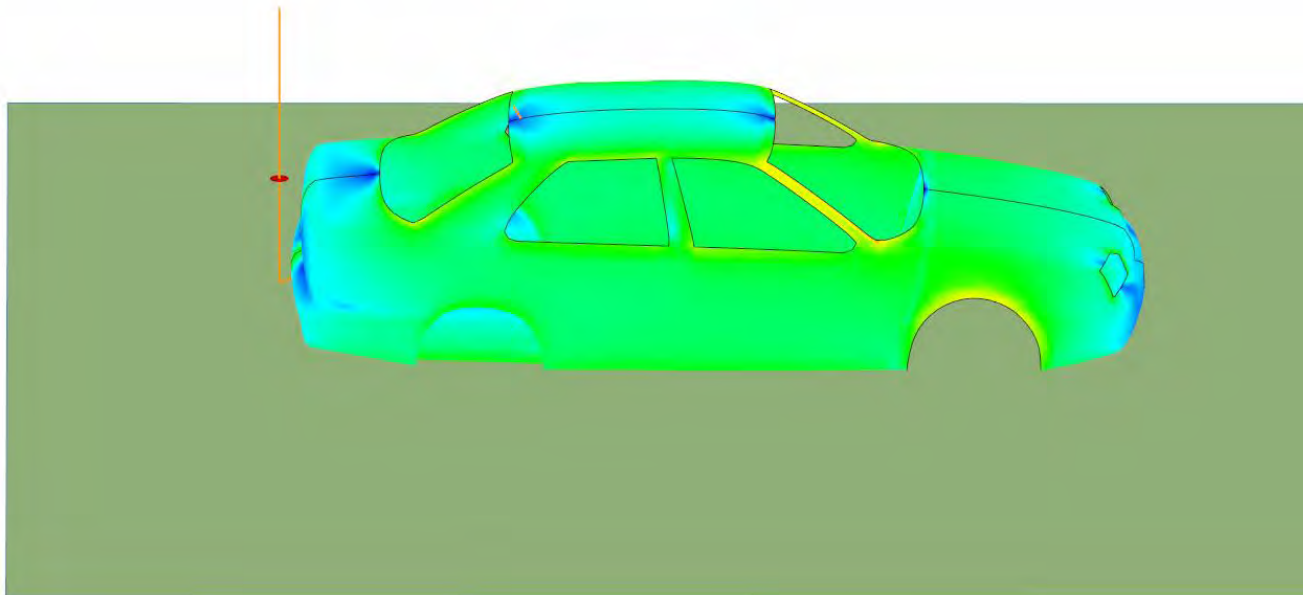
75 Watts Excitation



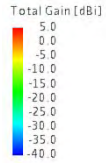
29 MHz on Rear (Earth Ground) Currents



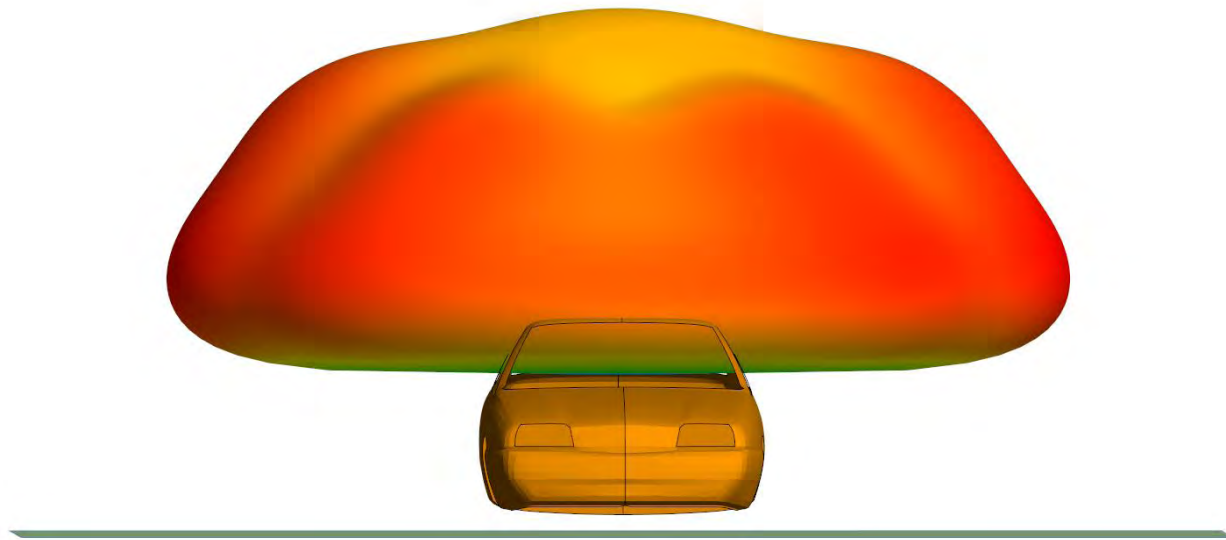
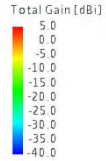
75 Watts Excitation



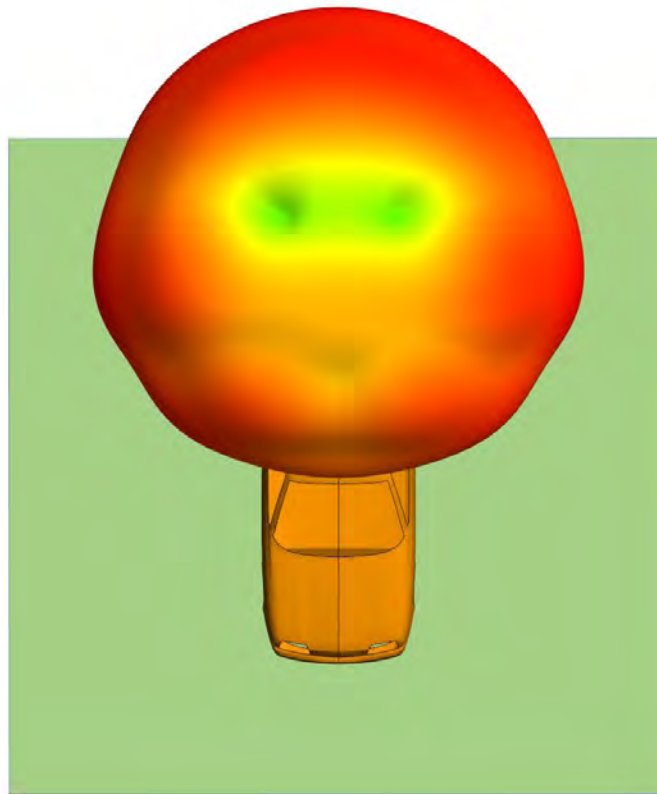
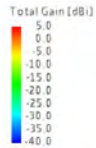
146.52 MHz on Rear (Earth Ground)



146.52 MHz on Rear (Earth Ground)

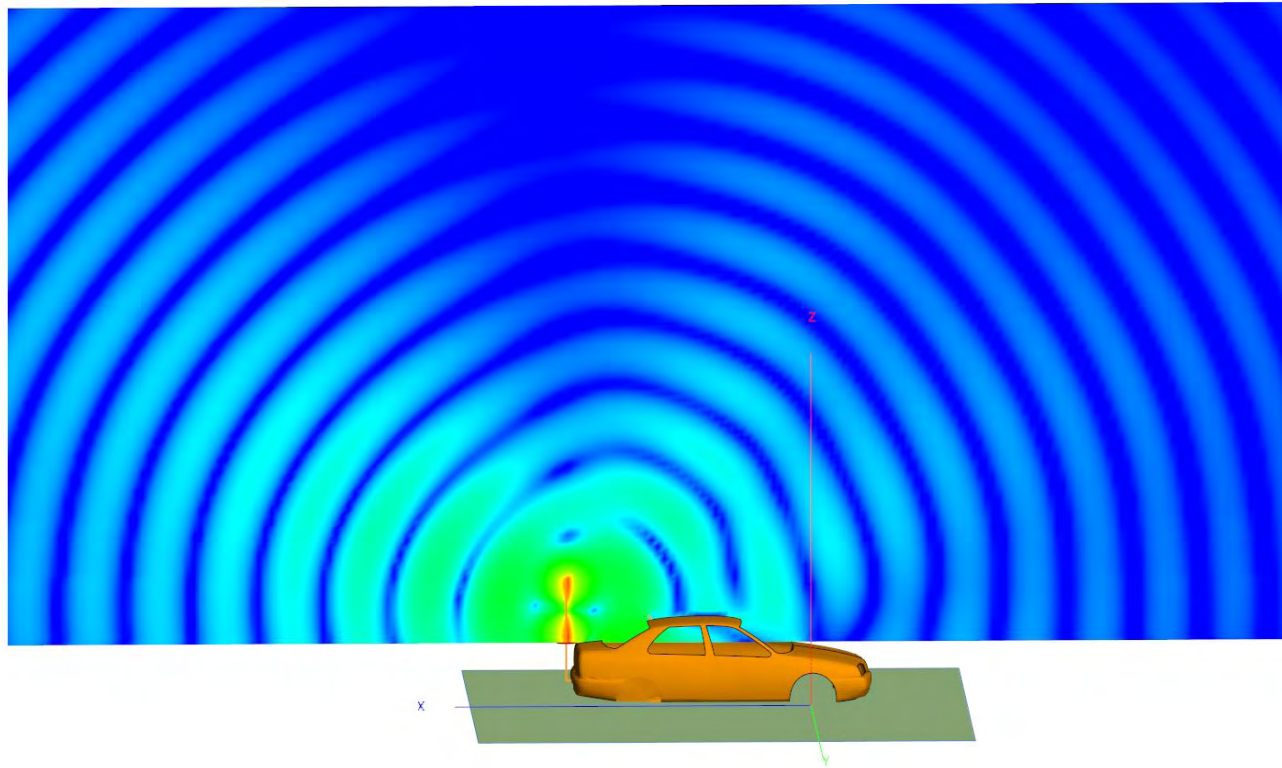
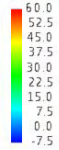


146.52 MHz on Rear (Earth Ground)



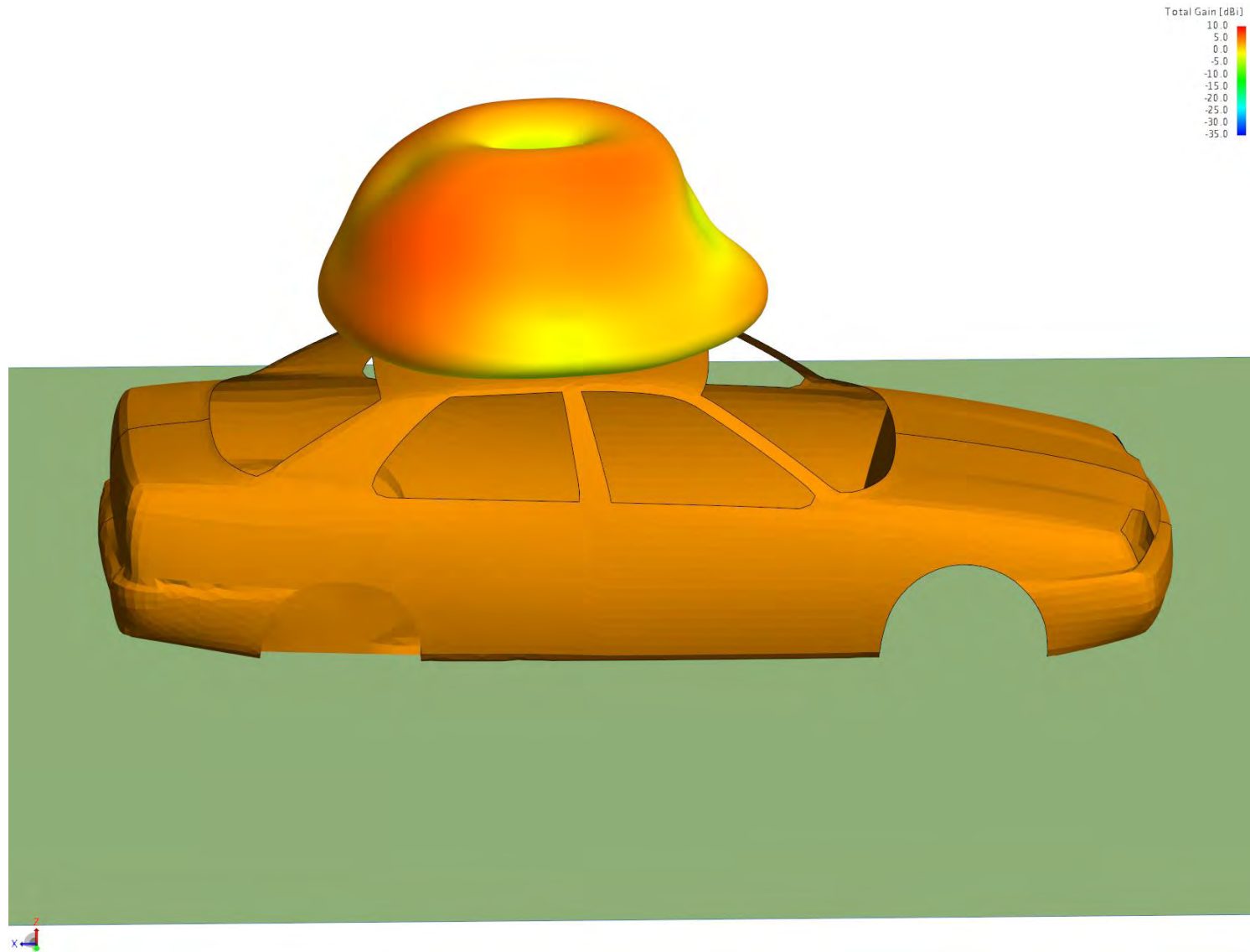
Near Field at 146.52 MHz on Rear (Earth Ground)

Instantaneous magnitude XYZ-E-Field [dBV/m]



2 Watts

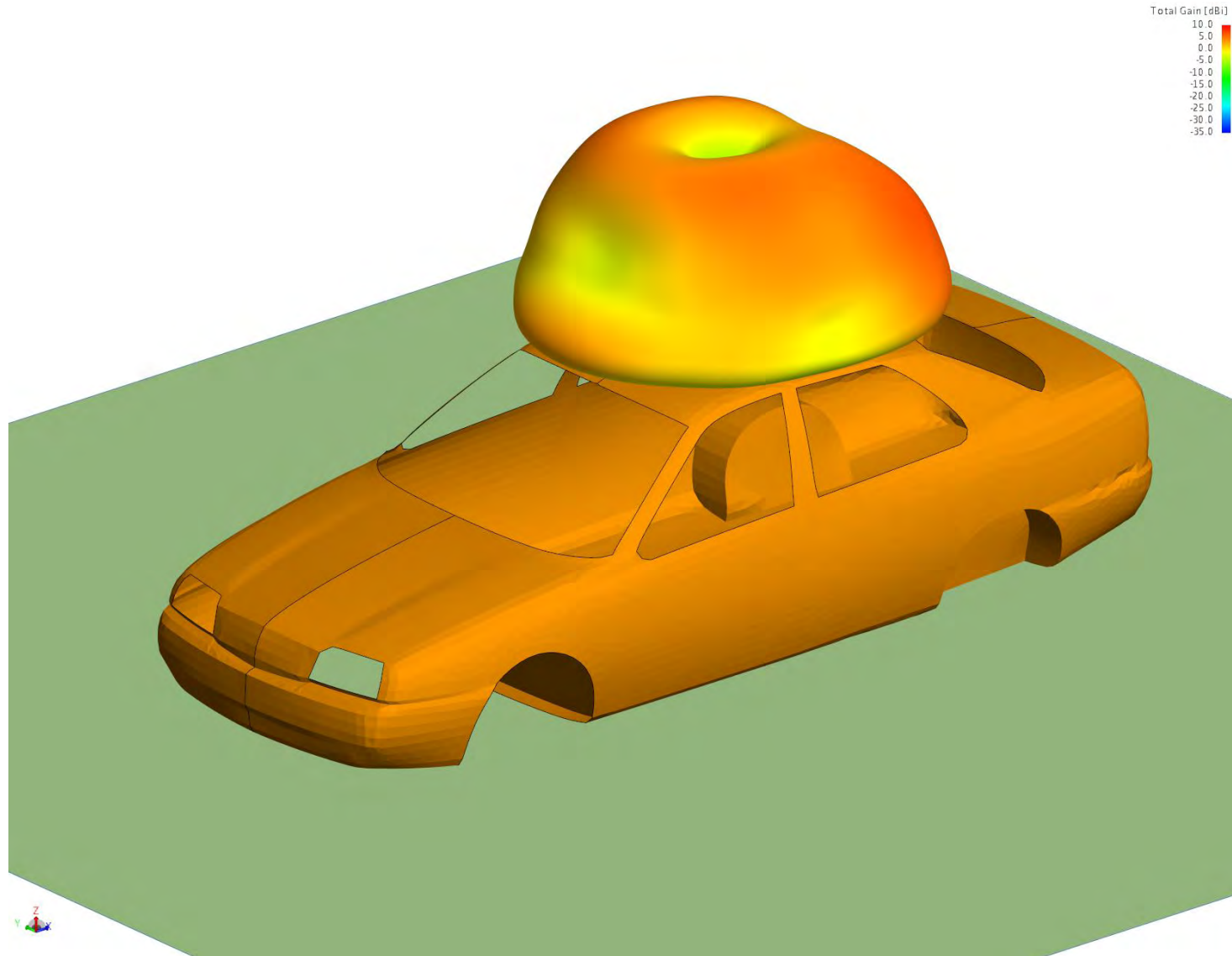
146.52 MHz on Roof (Earth Ground)



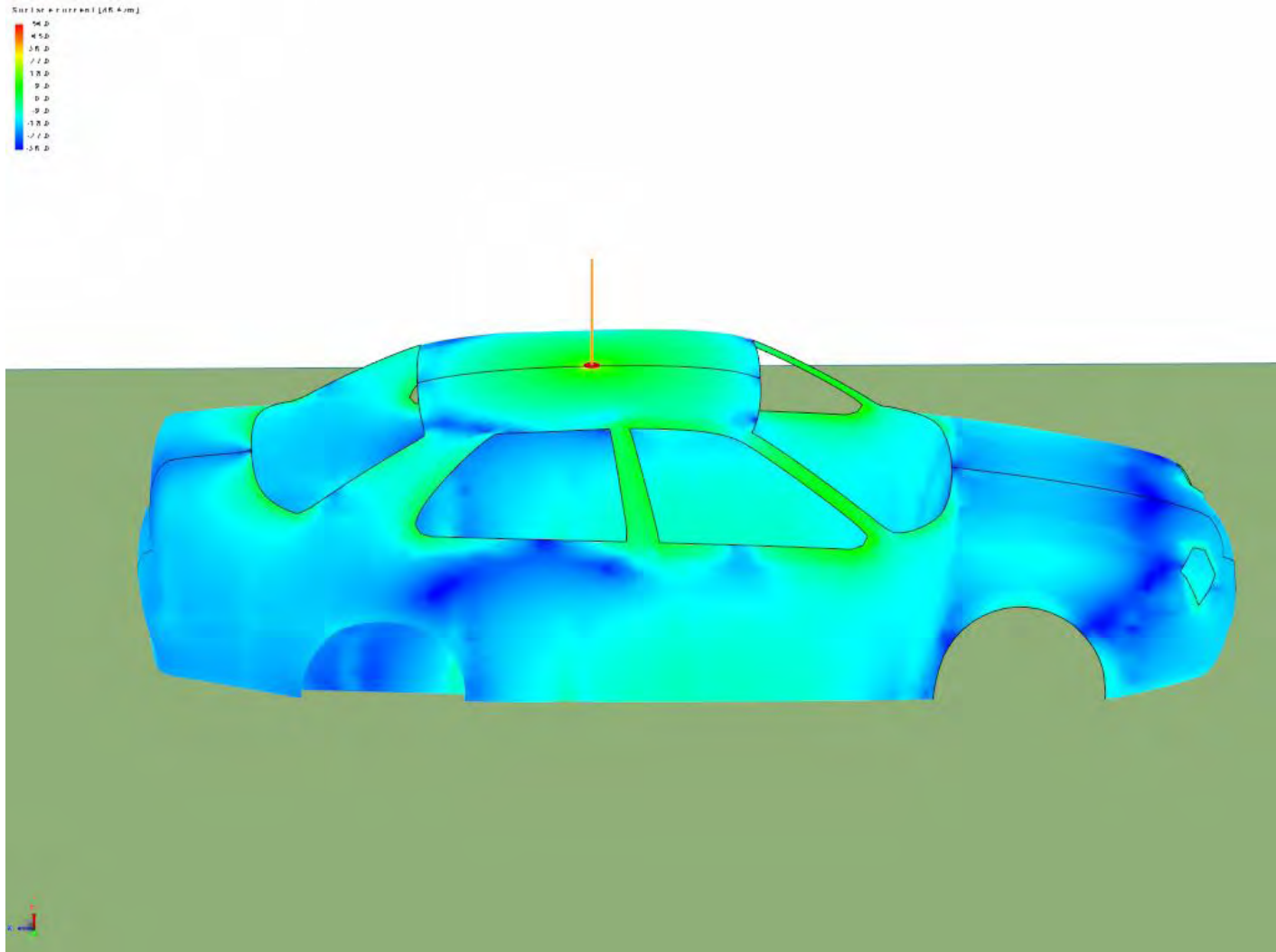
146.52 MHz on Roof (Earth Ground)



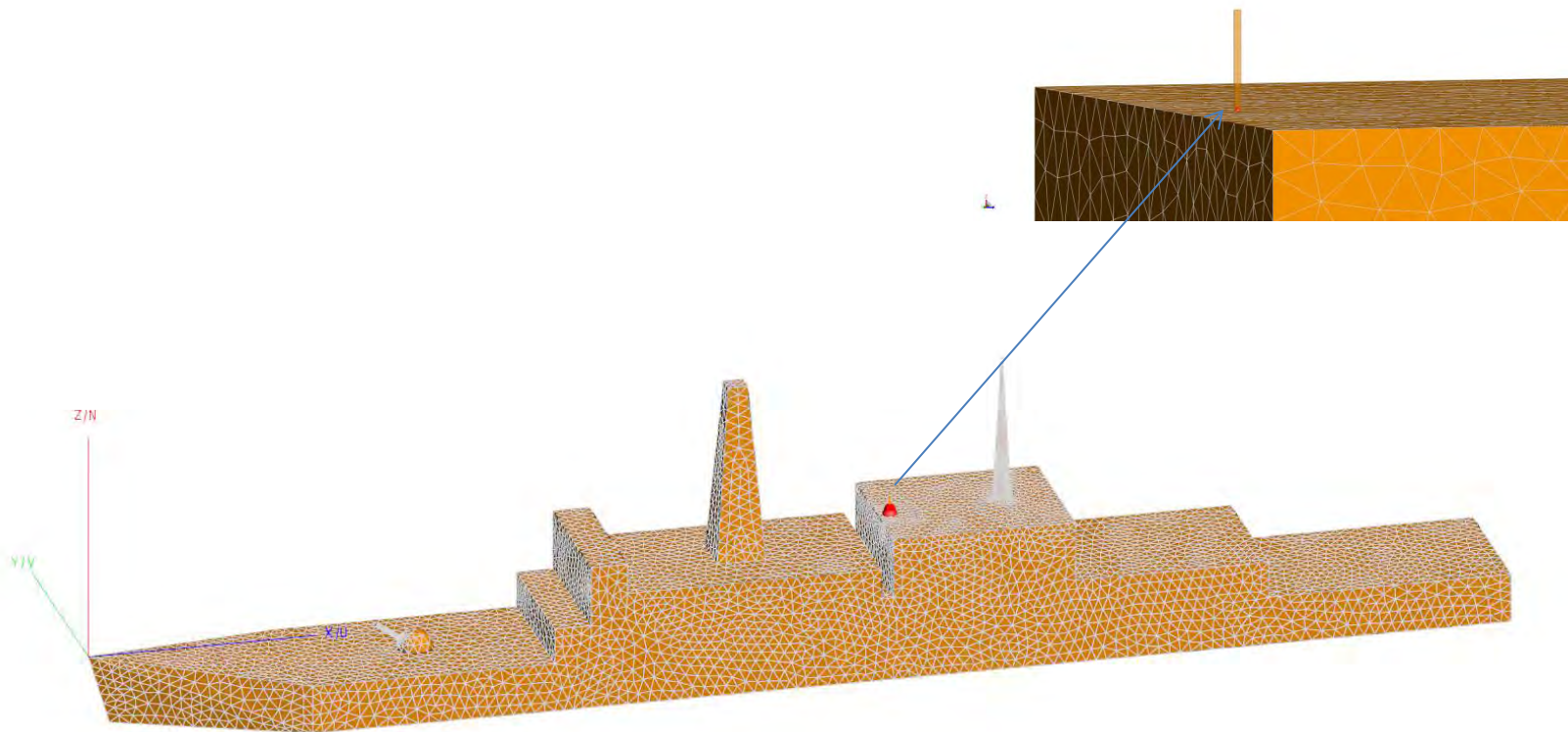
146.52 MHz on Roof (Earth Ground)



146.52 MHz Instantaneous Currents



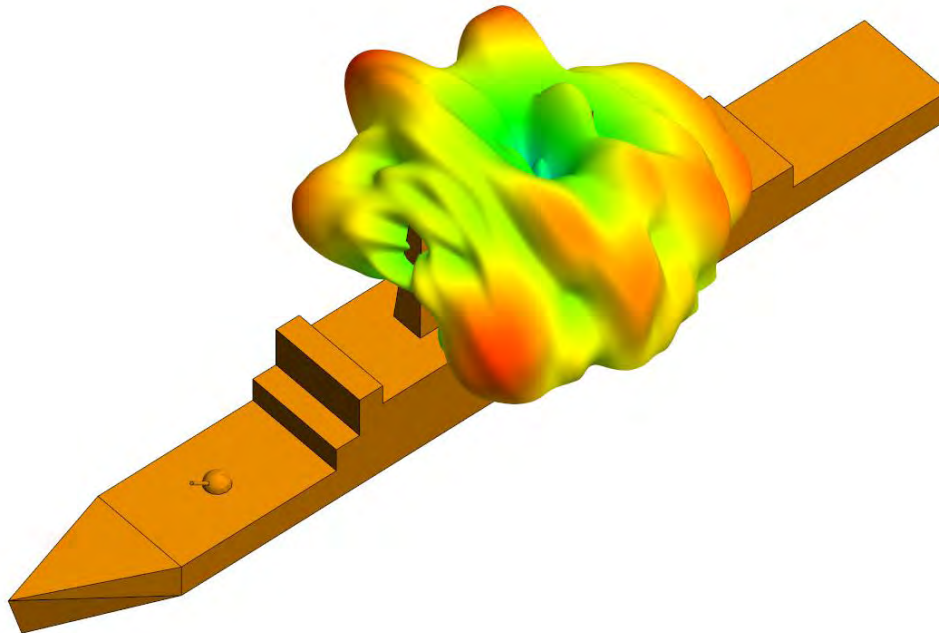
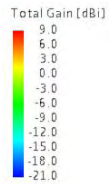
Ship with Monopole at 50 MHz Power 75 Watts



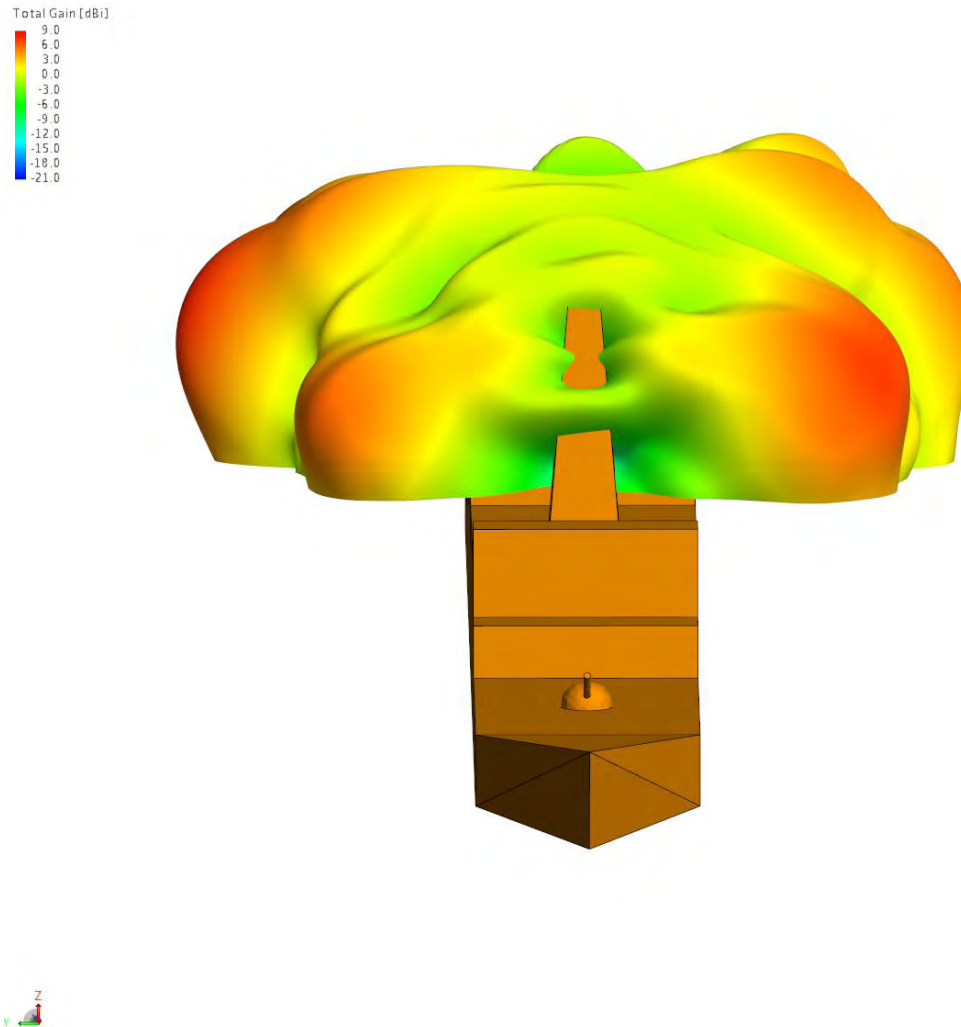
Number of Triangles = 12,848



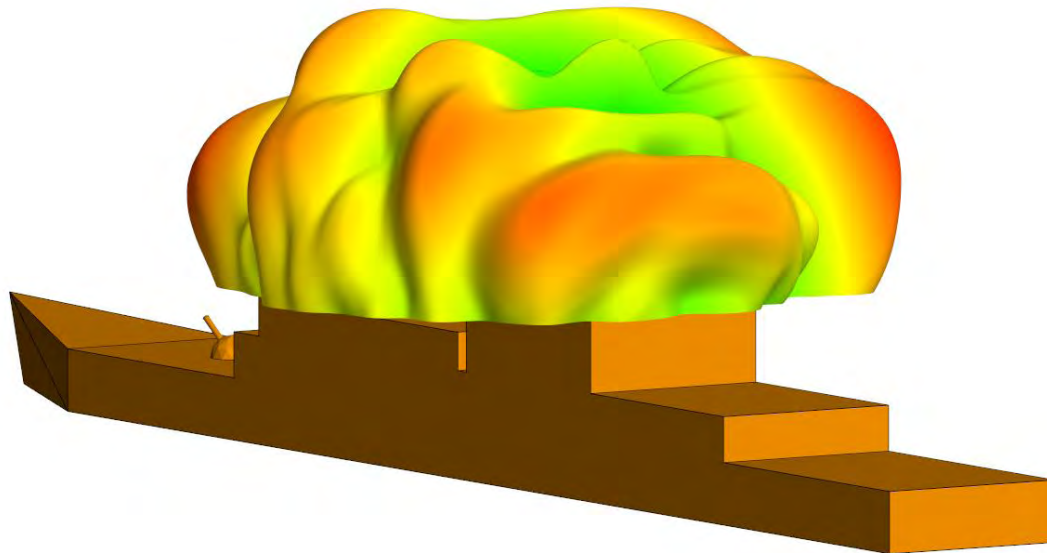
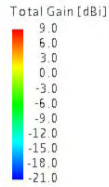
Ship with Monopole at 50 MHz Antenna Pattern



Ship with Monopole at 50 MHz Antenna Pattern

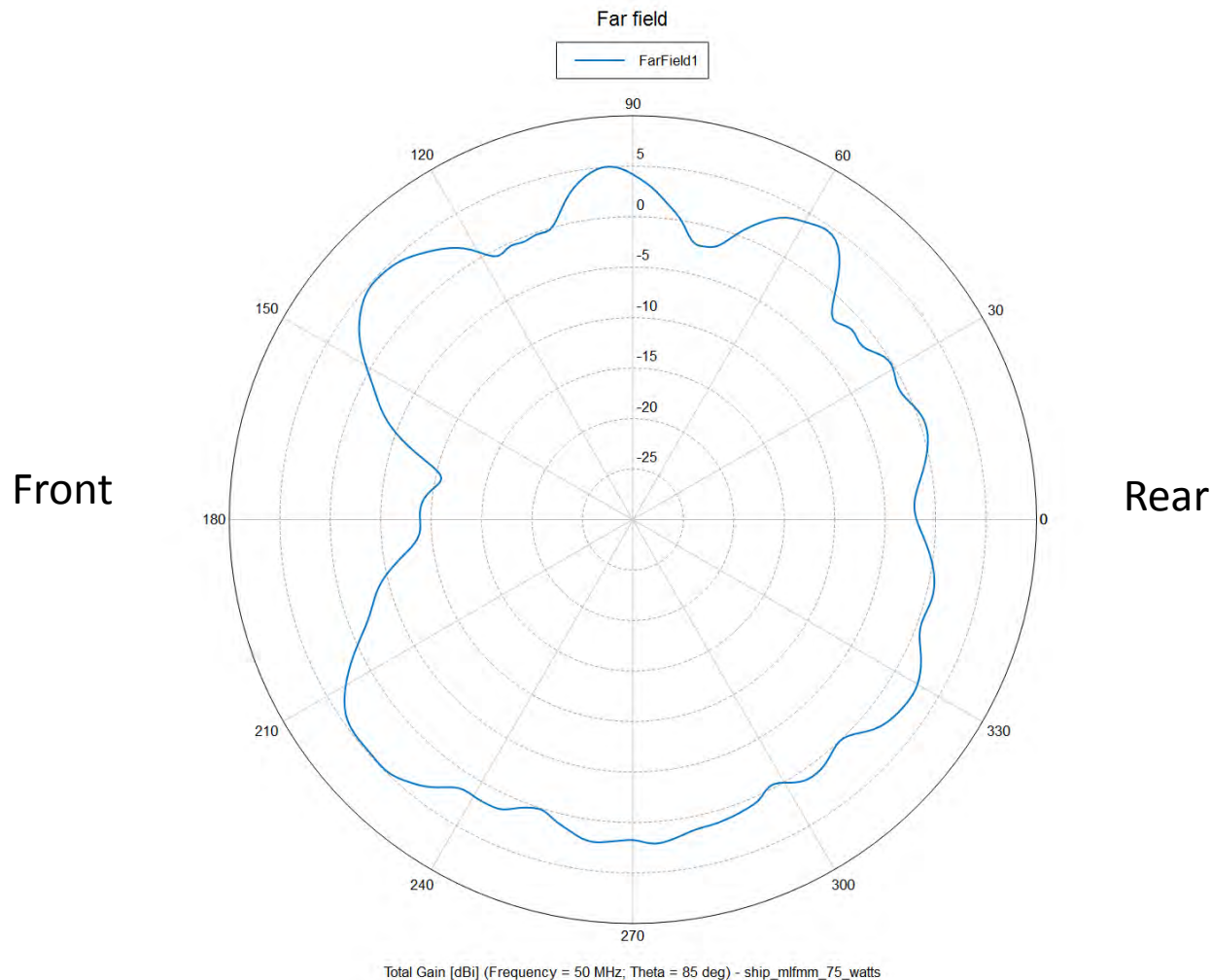


Ship with Monopole at 50 MHz Antenna Pattern



Ship with Monopole at 50 MHz

Antenna Pattern 5 degrees Elevation

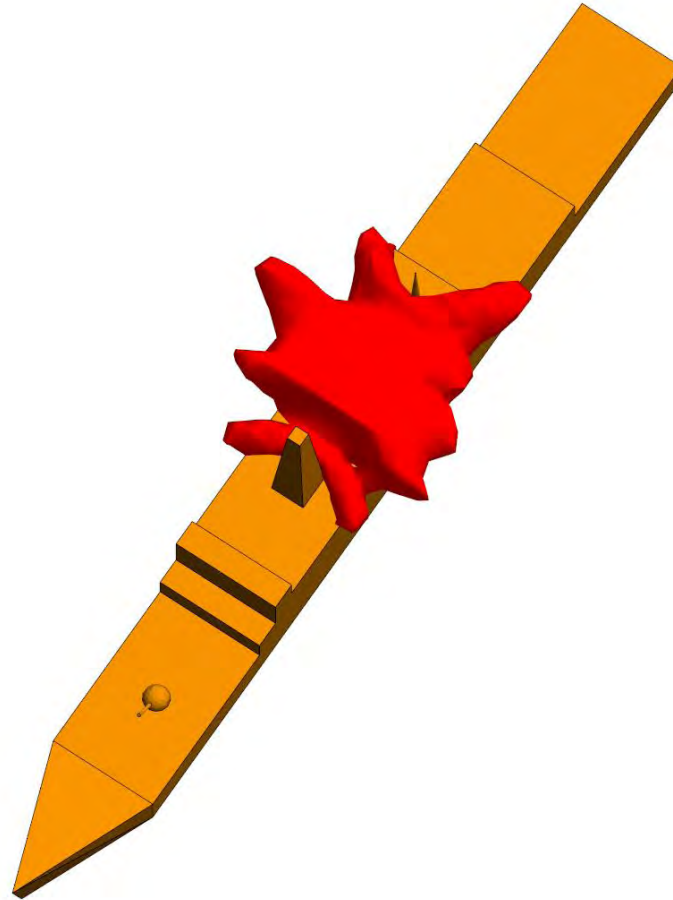


Ship with Monopole at 50 MHz

Near Field Antenna Pattern

XYZ E-Field [V/m]

90.0
81.0
72.0
63.0
54.0
45.0
36.0
27.0
18.0
9.0
0.0



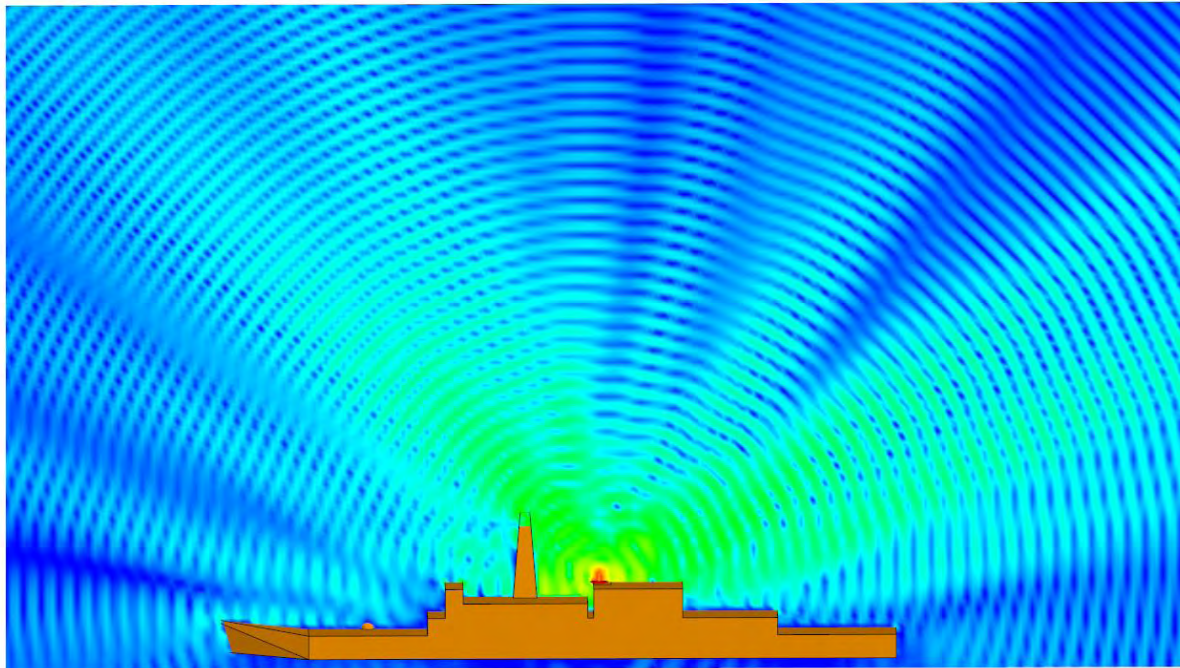
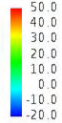
9.92 V/m



Ship with Monopole at 50 MHz

Near Field Antenna Pattern

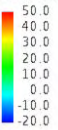
Instantaneous magnitude XYZ E-Field [dBV/m]



Ship with Monopole at 50 MHz

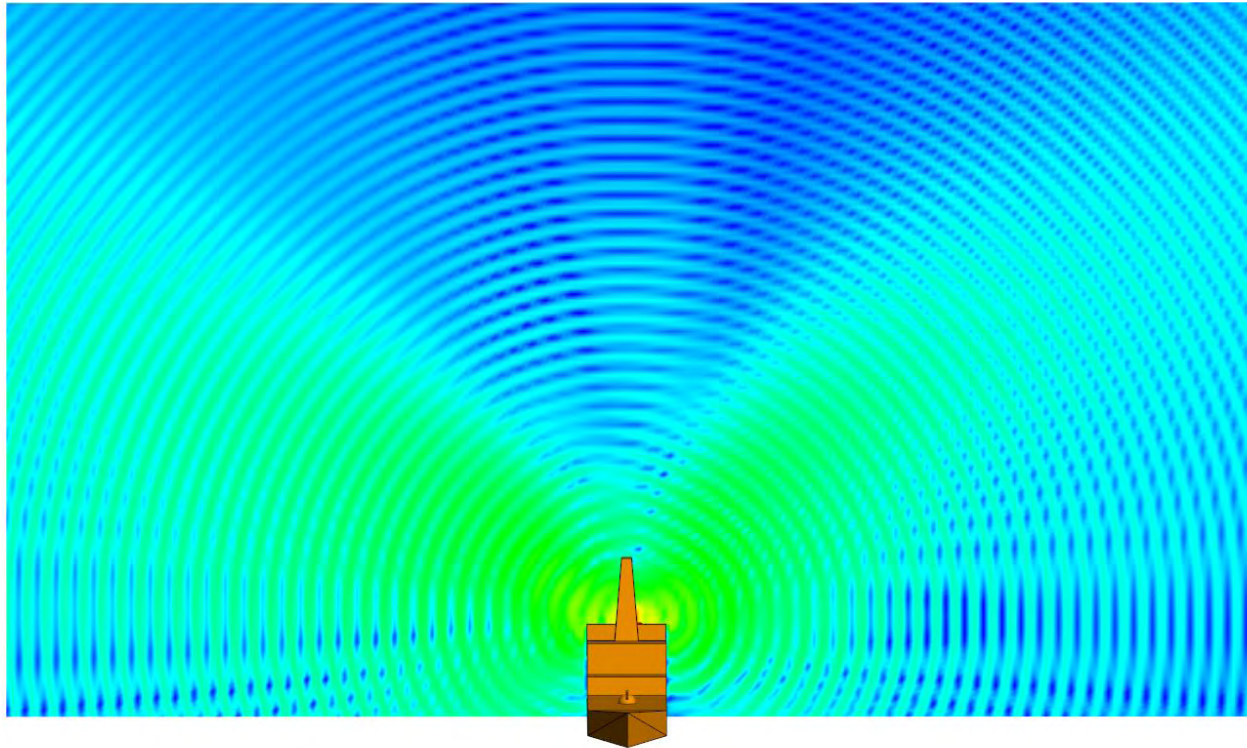
Near Field Antenna Pattern

Instantaneous magnitude XYZ E-Field [dBV/m]

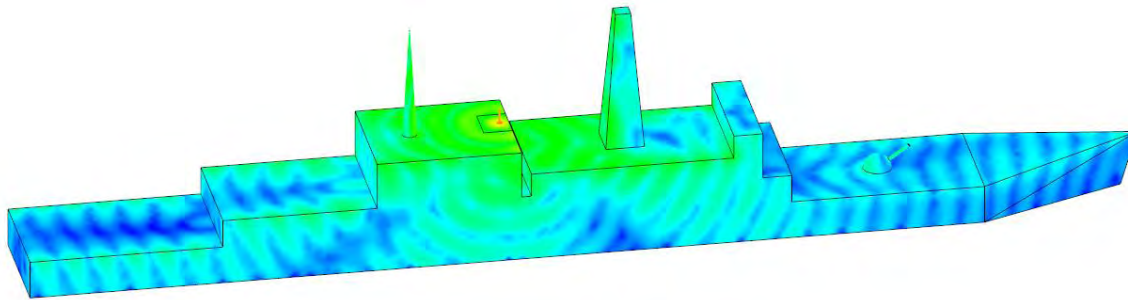
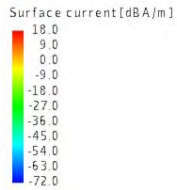


A vertical color scale bar ranging from -20.0 to 50.0 dBV/m. The colors transition from blue at the bottom (-20.0) through green (0.0) to red at the top (50.0). Tick marks are present at intervals of 10.0.

Instantaneous magnitude XYZ E-Field [dBV/m]
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
-20.0

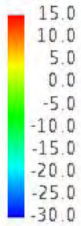


Ship with Monopole at 50 MHz Skin Currents



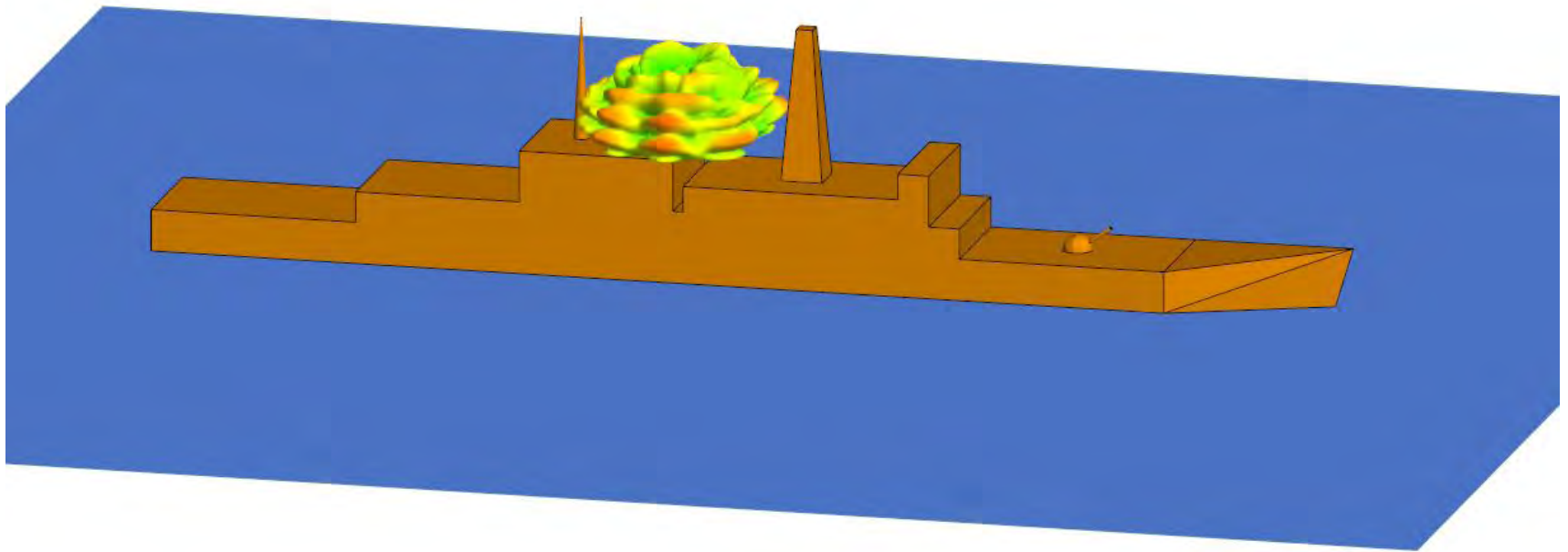
Ship 50 MHz with Sea Water

Total Gain [dBi]



$\epsilon_r = 80$

$\sigma = 5 \text{ mhos/m}$



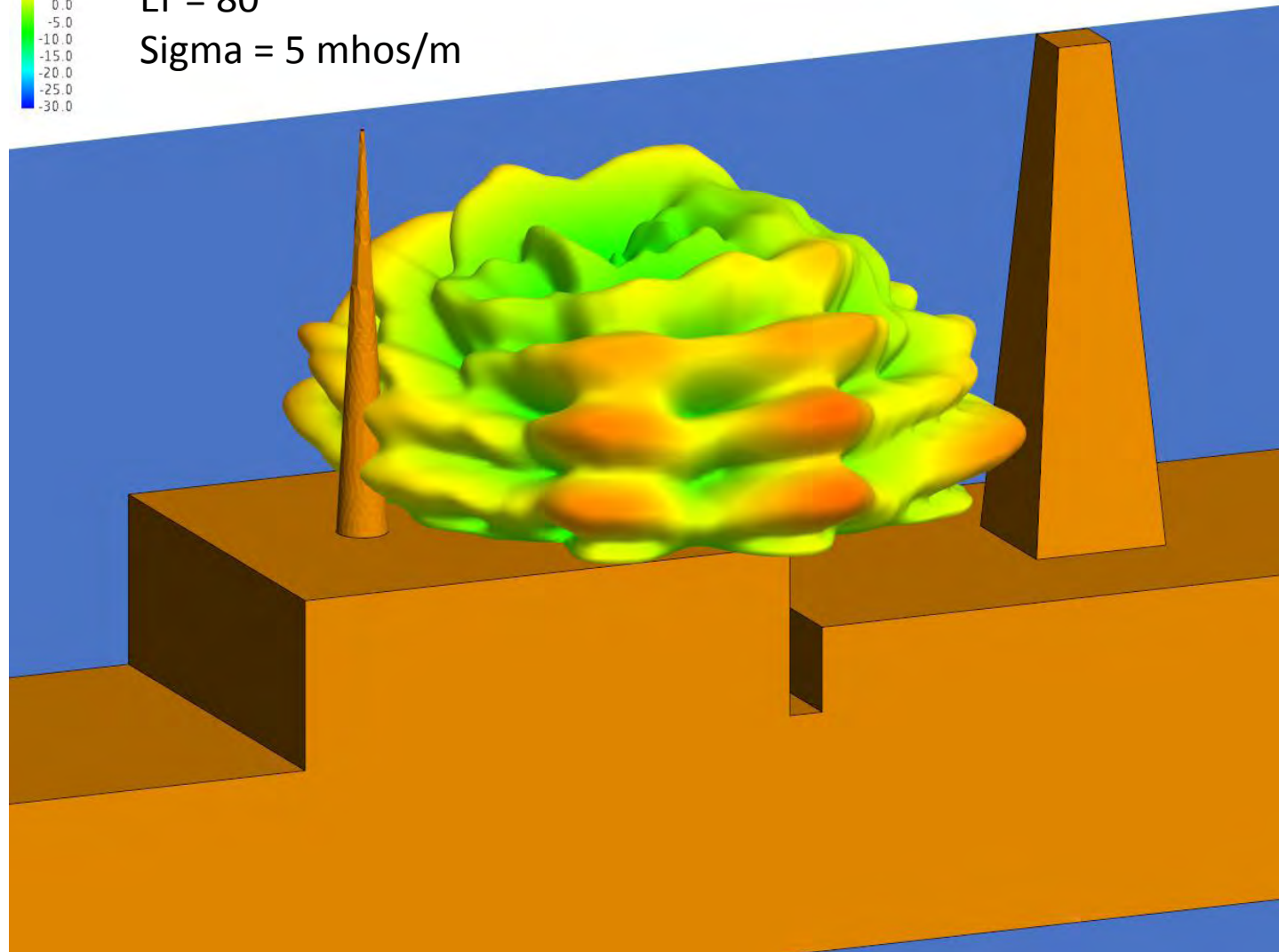
Ship 50 MHz with Sea Water

Total Gain [dBi]



$\epsilon_r = 80$

$\sigma = 5 \text{ mhos/m}$



Helicopter Model



Helicopter with 2 Meter Band Monopole 100 Watts

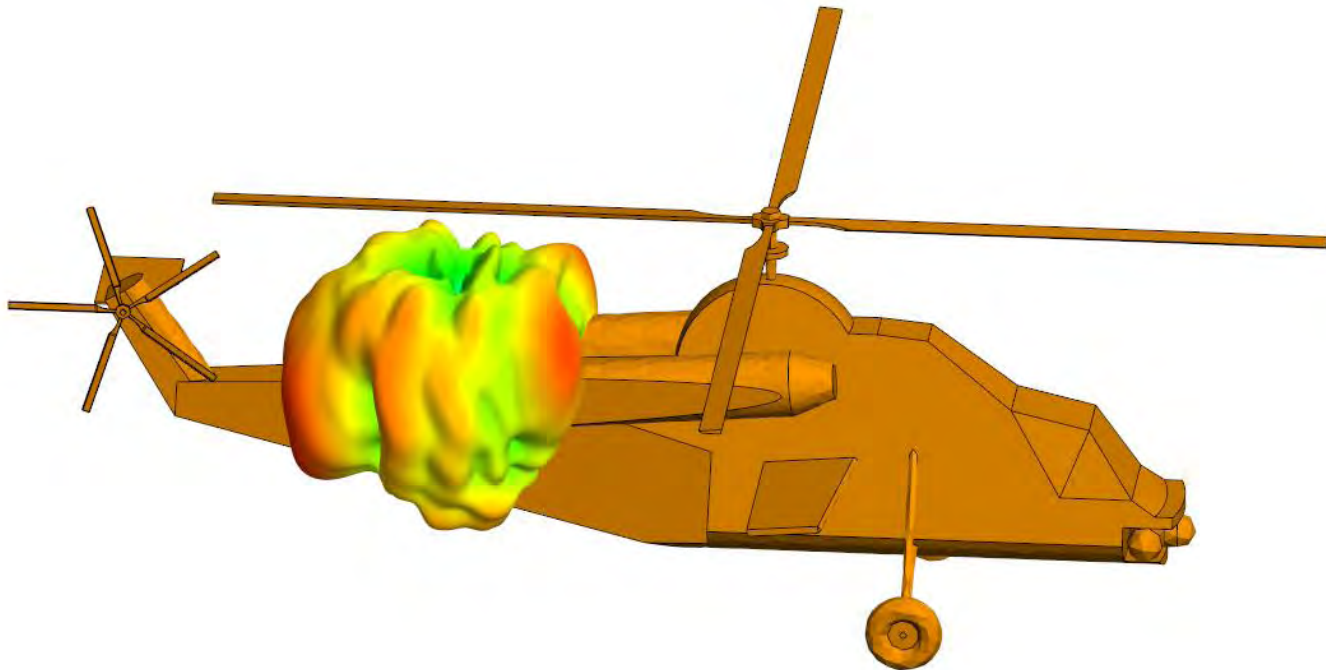
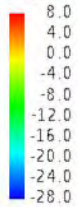


Number of Triangles = 11,726

Helicopter Antenna Pattern

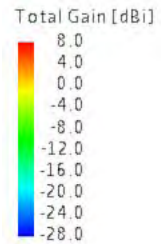
144 MHz

Total Gain [dBi]



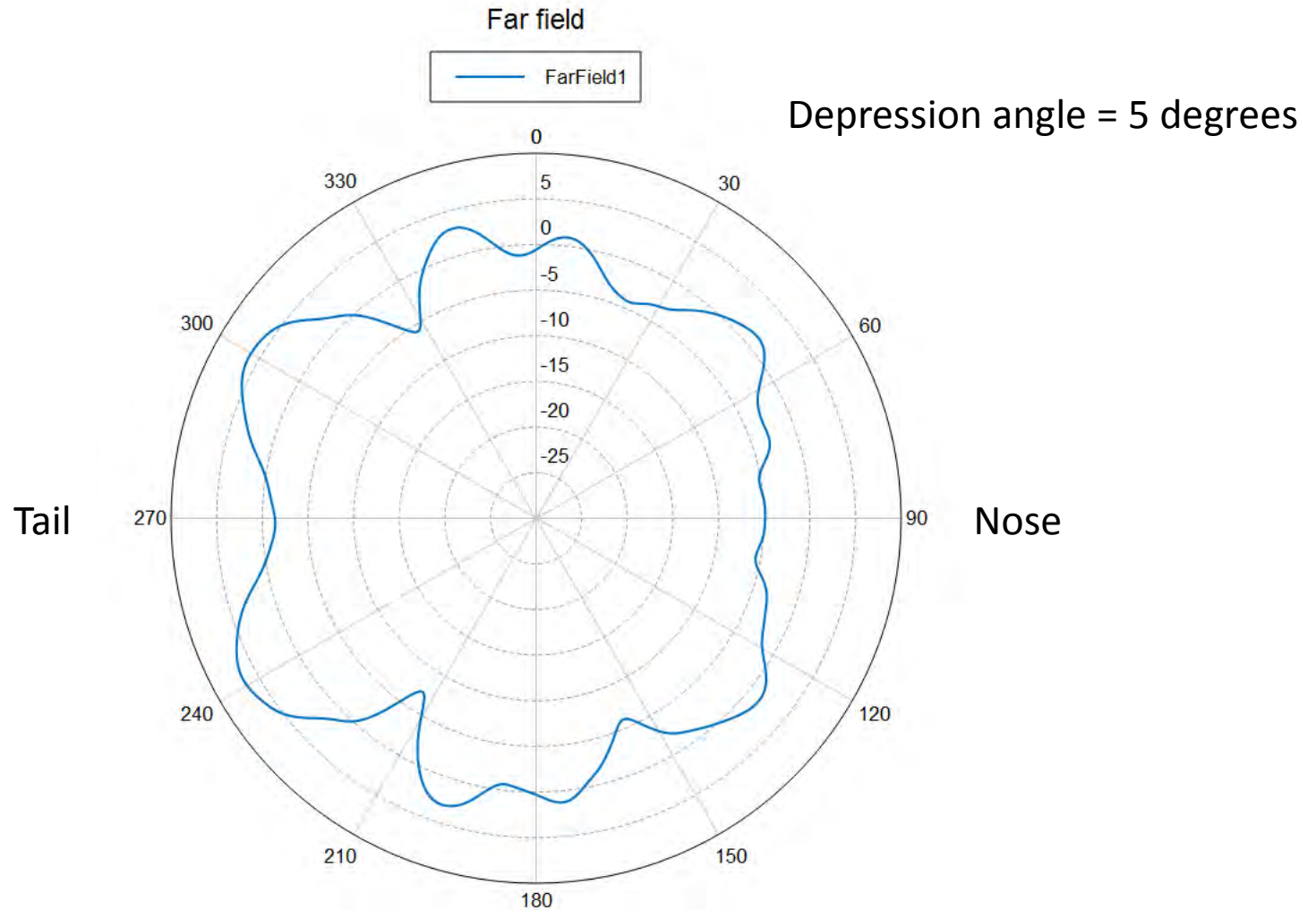
Helicopter Antenna Pattern

144 MHz



Helicopter Antenna Pattern

144 MHz

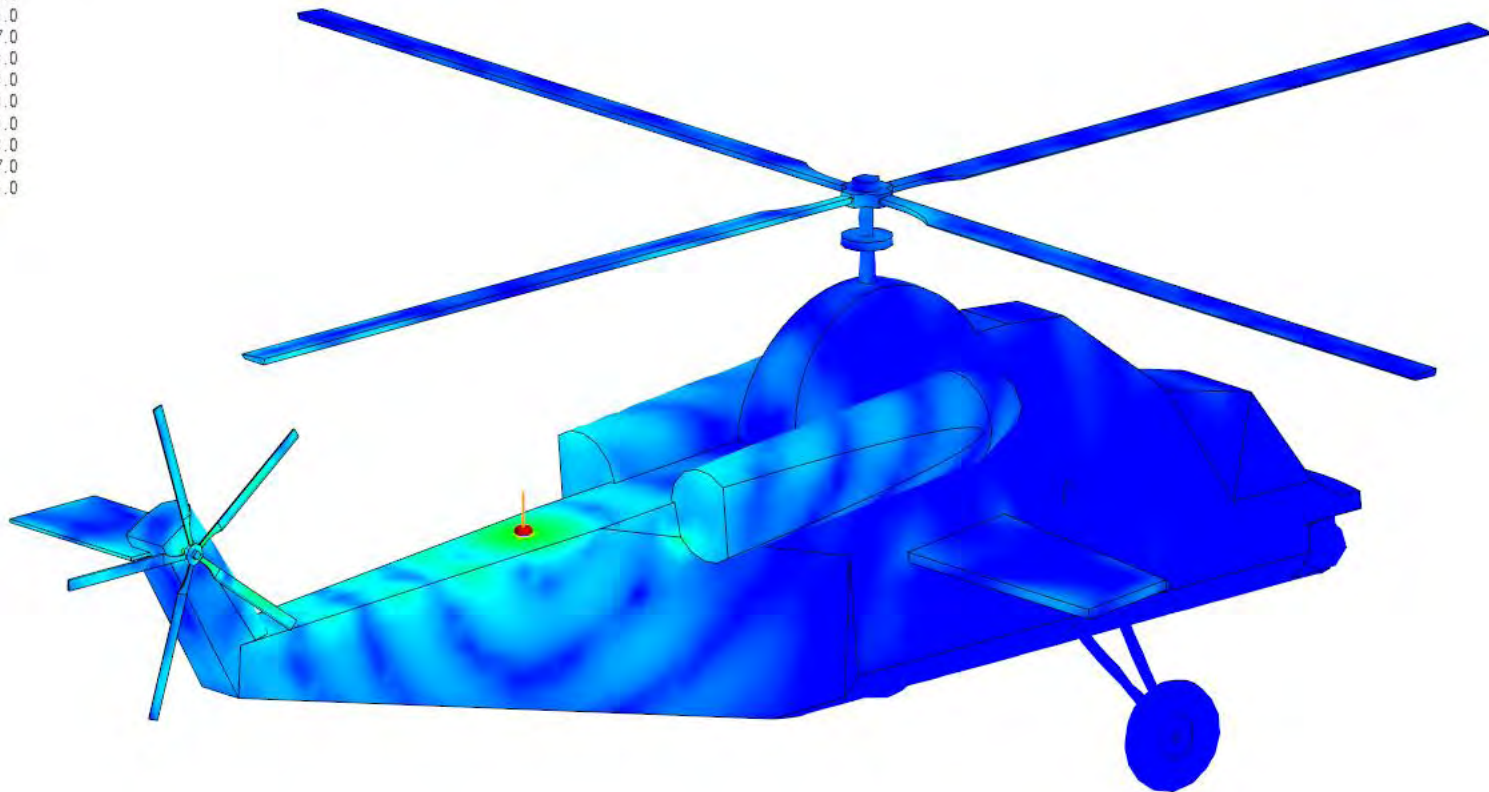
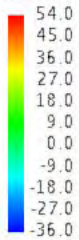


Total Gain [dBi] (Frequency = 144 MHz; Theta = 95 deg) - Generic_attack_helicopter_6p1

Helicopter

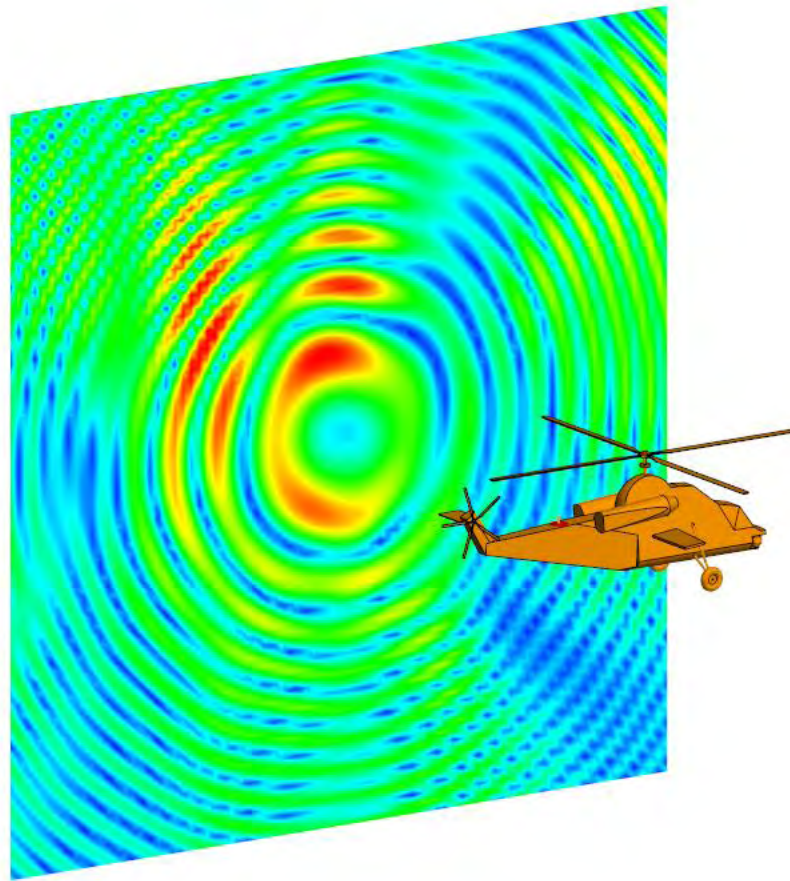
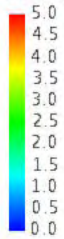
Skin Currents 144 MHz

Surface current [dBA/m]



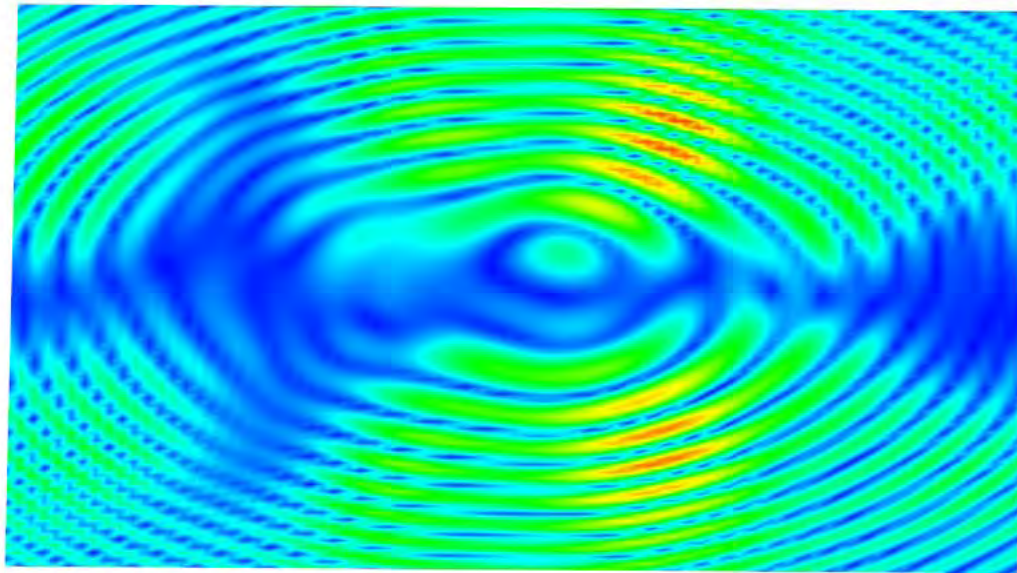
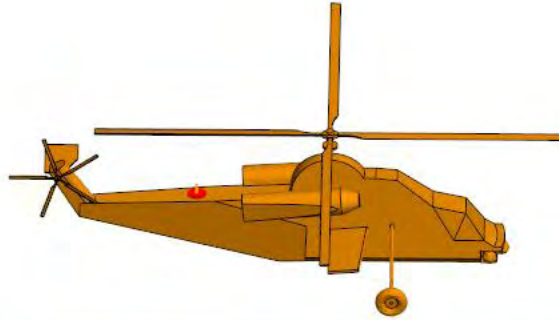
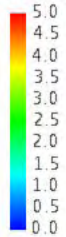
Helicopter Near Field Pattern 144 MHz

Instantaneous magnitude XYZ E-Field [V/m]



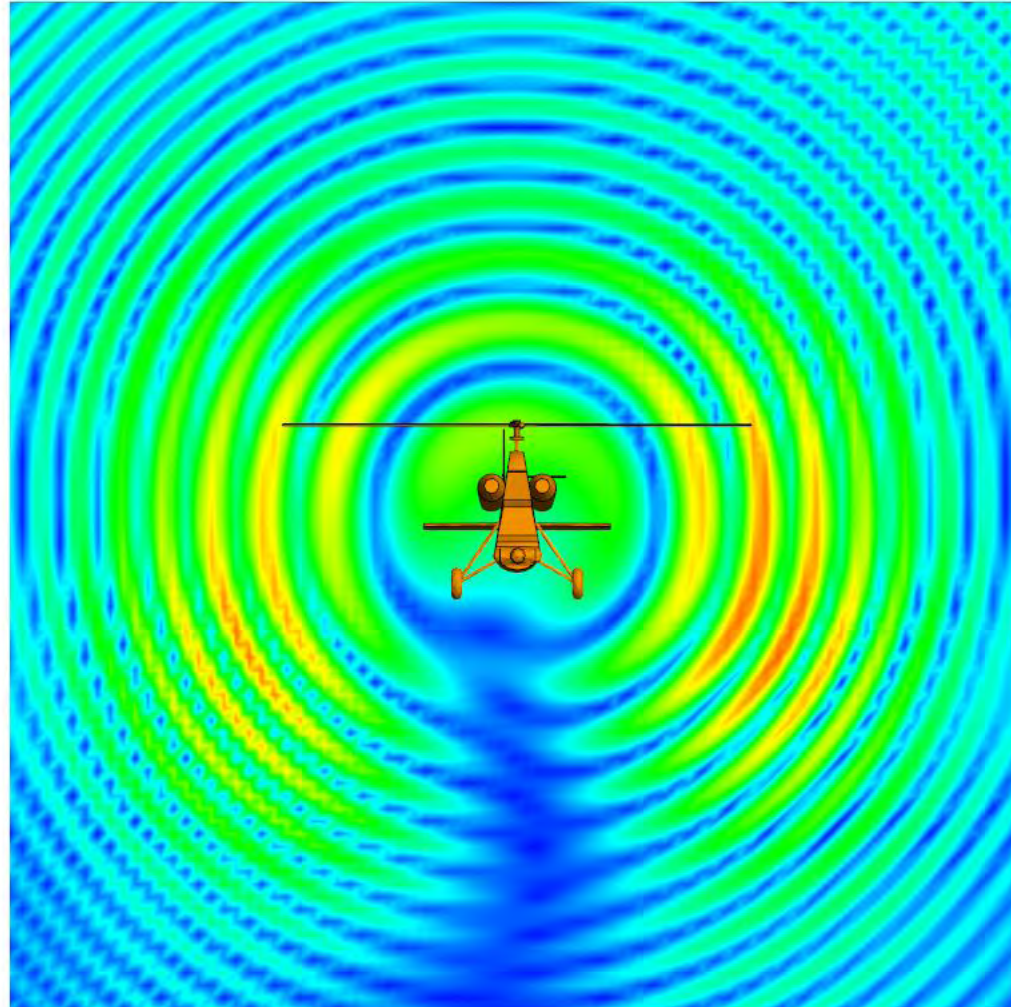
Helicopter Near Field Pattern 144 MHz

Instantaneous magnitude XYZ E-Field [V/m]



Helicopter Near Field Pattern 144 MHz

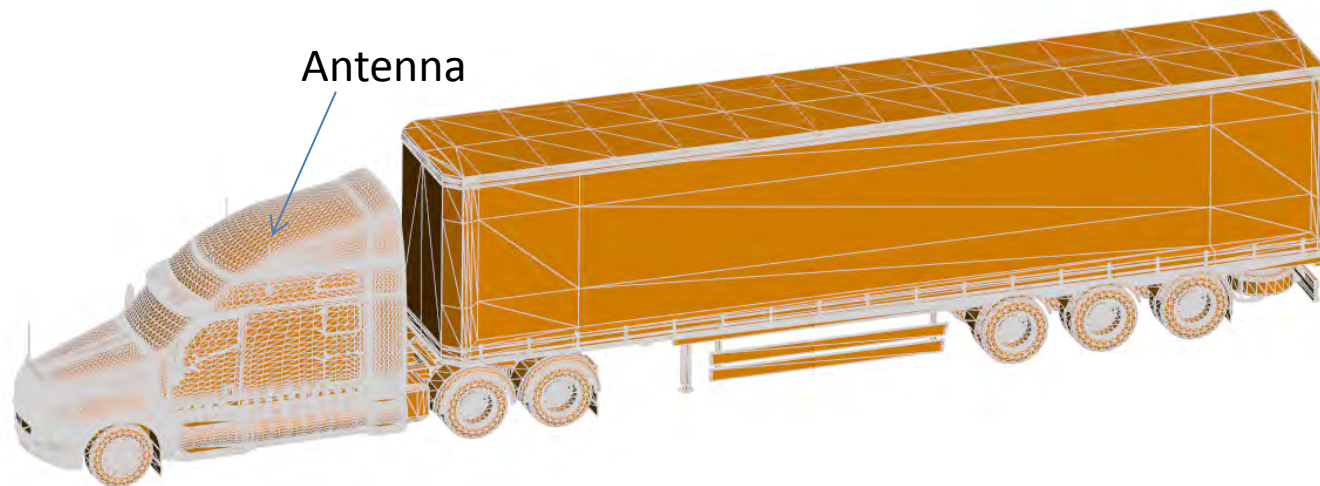
Instantaneous magnitude XYZ E-Field [V/m]



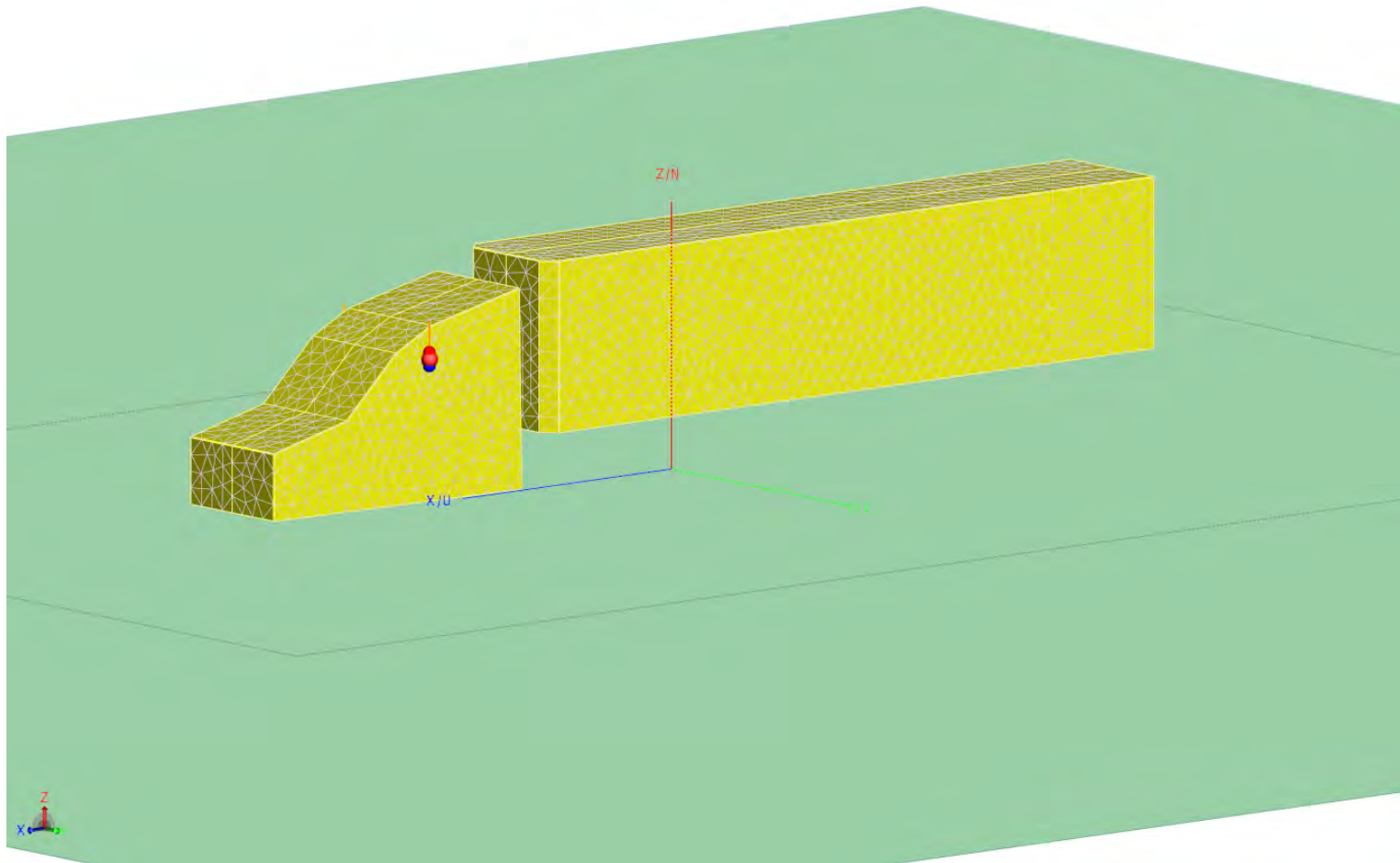
Peterbilt Truck



Peterbilt Semi Antenna Model



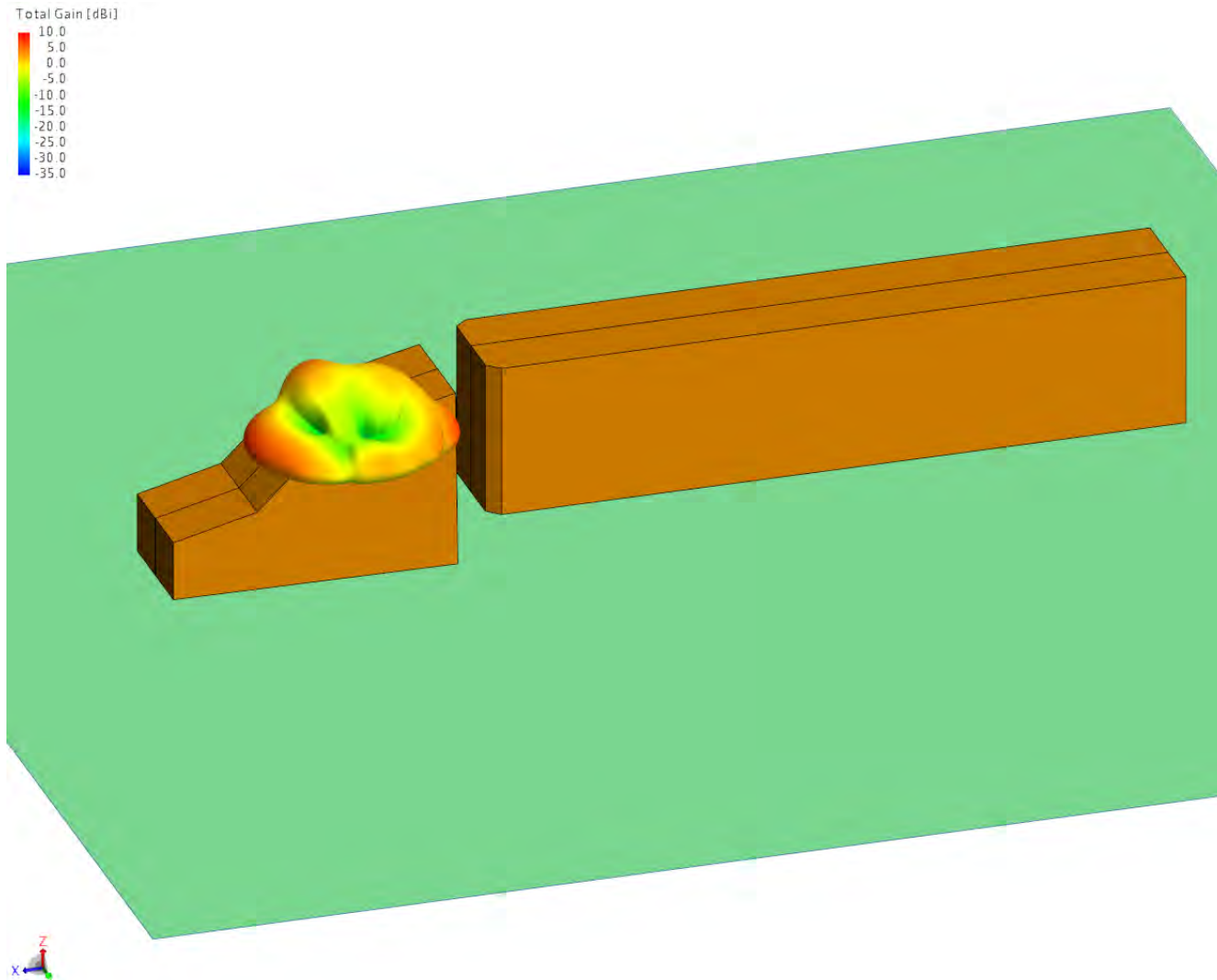
Peterbilt Semi Antenna Model



Number of Triangles = 5,138

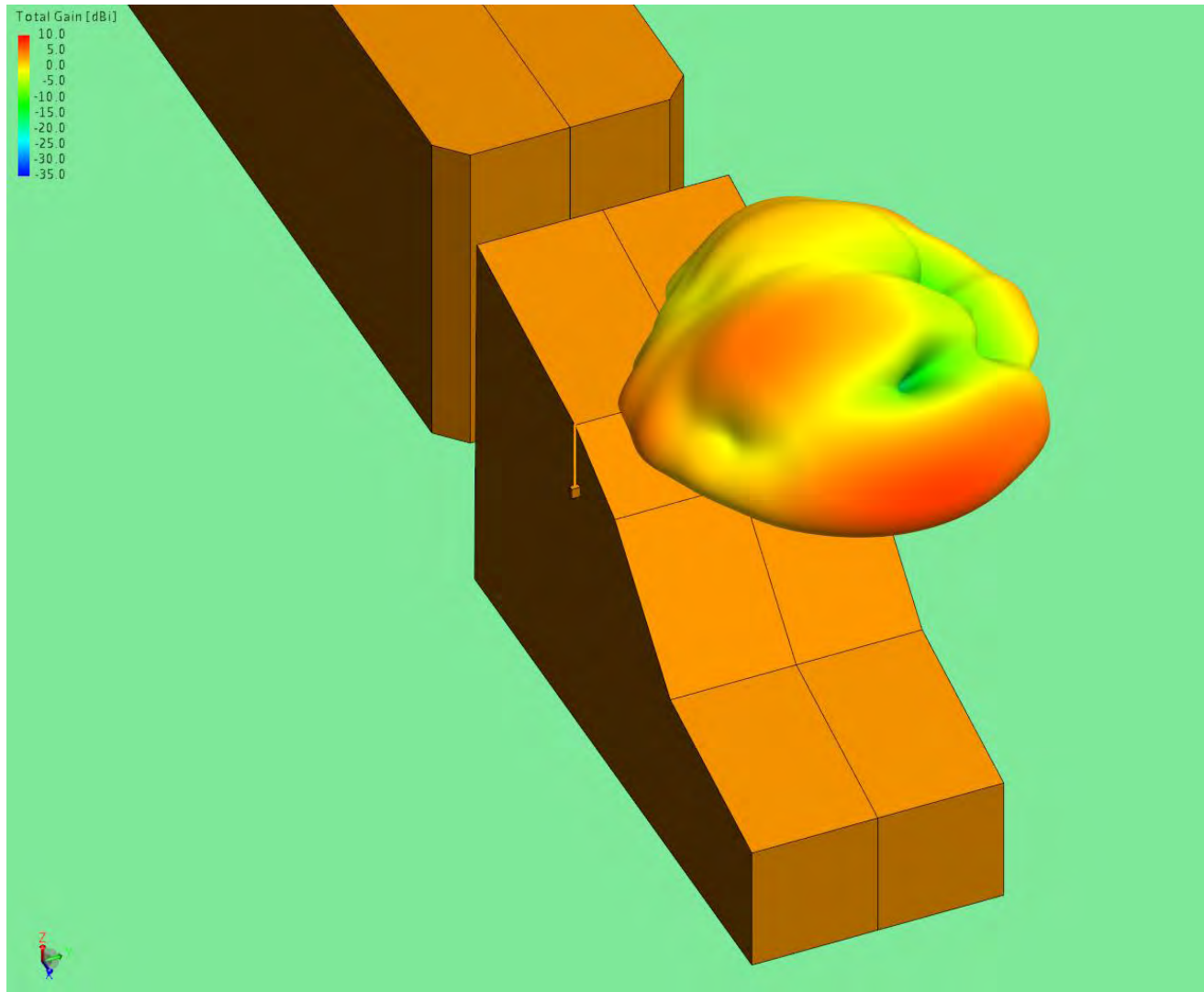
Peterbilt Semi Antenna Pattern

27 MHz



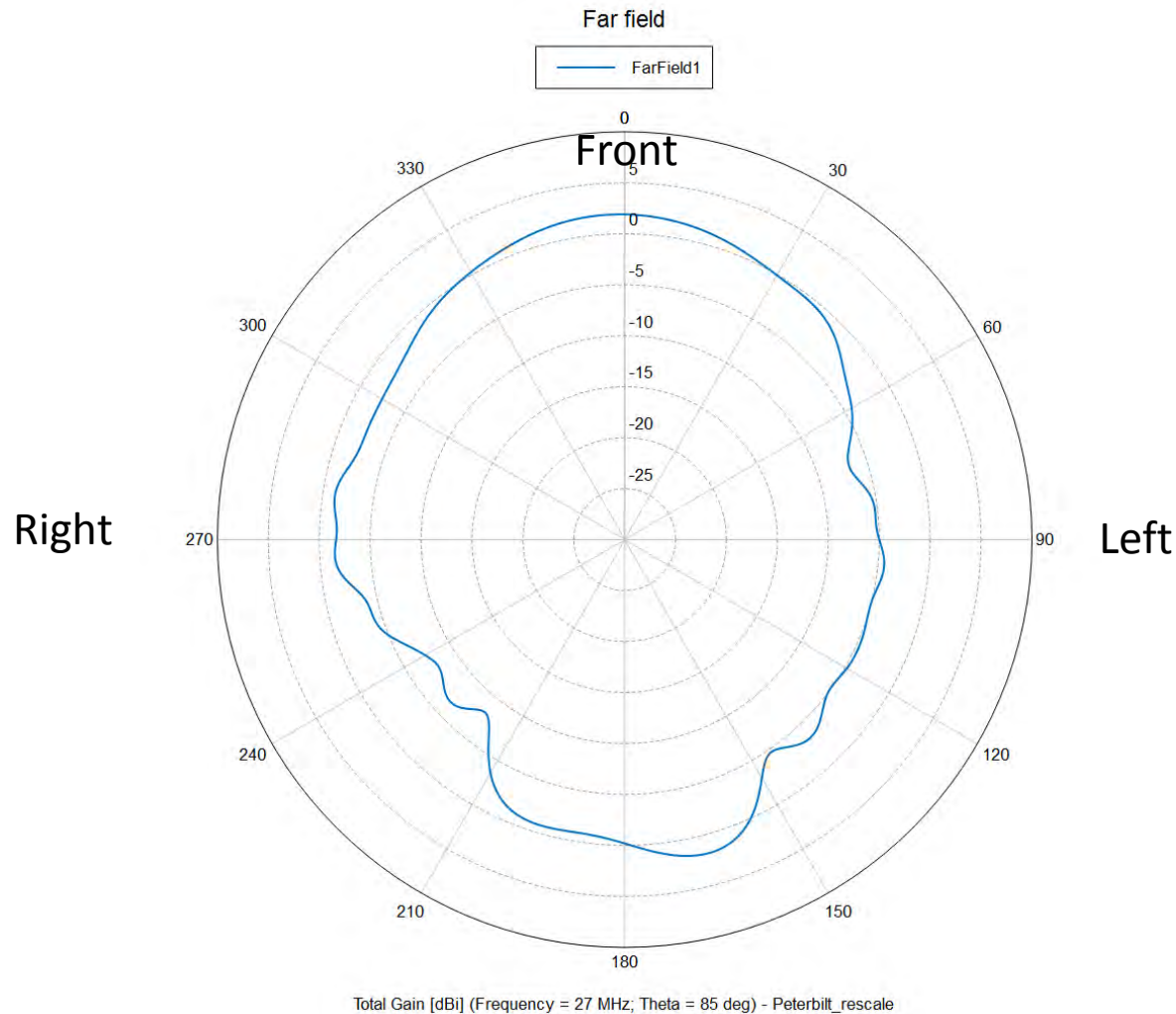
Peterbilt Semi Antenna Pattern

27 MHz



Peterbilt Semi Antenna Pattern

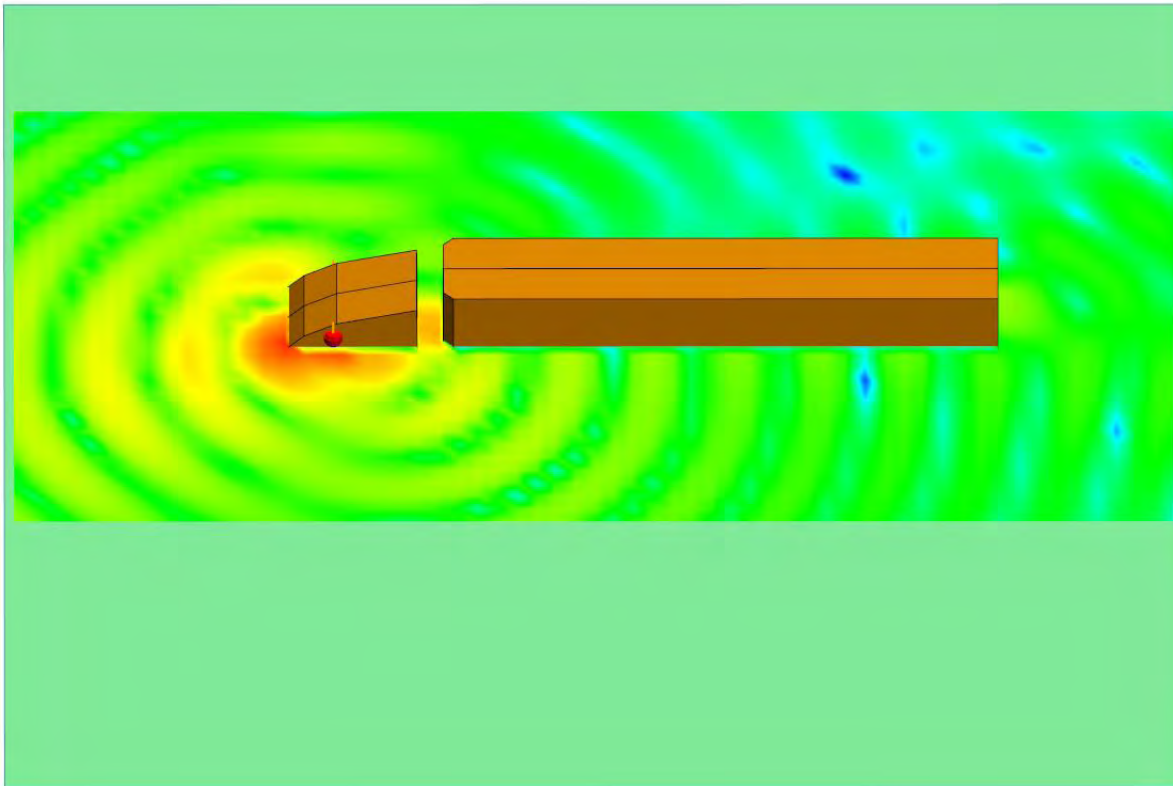
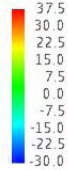
27 MHz Elevation = 5 degrees



Peterbilt Semi 27 MHz

Near Field Antenna Pattern 100 Watts

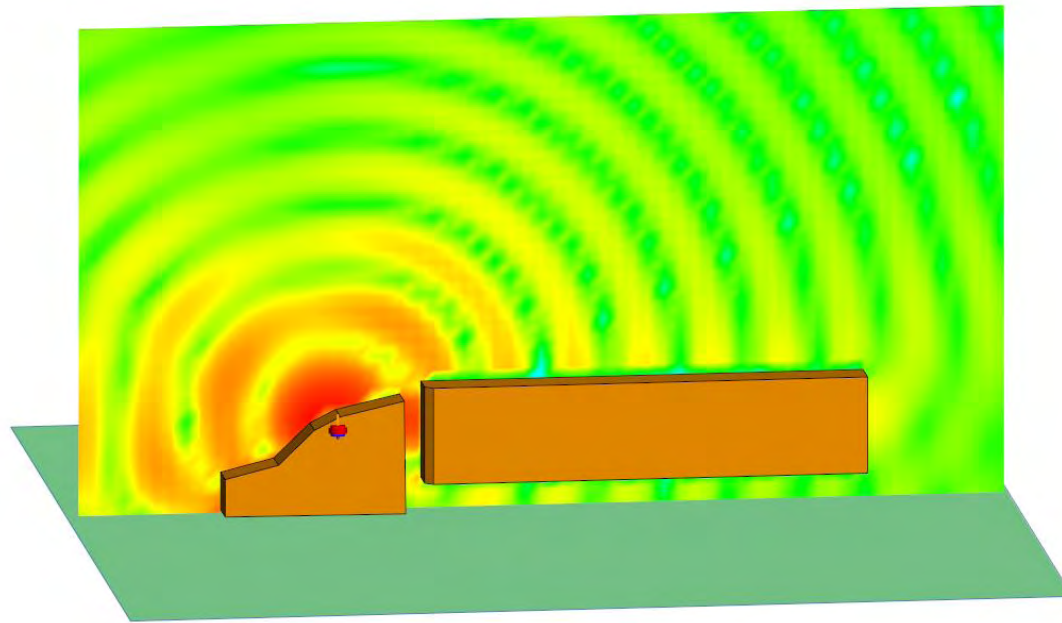
Instantaneous magnitude XYZ E-Field [dBV/m]



Peterbilt Semi 27 MHz

Near Field Antenna Pattern 100 Watts

Instantaneous magnitude XYZ-Field [dBV/m]

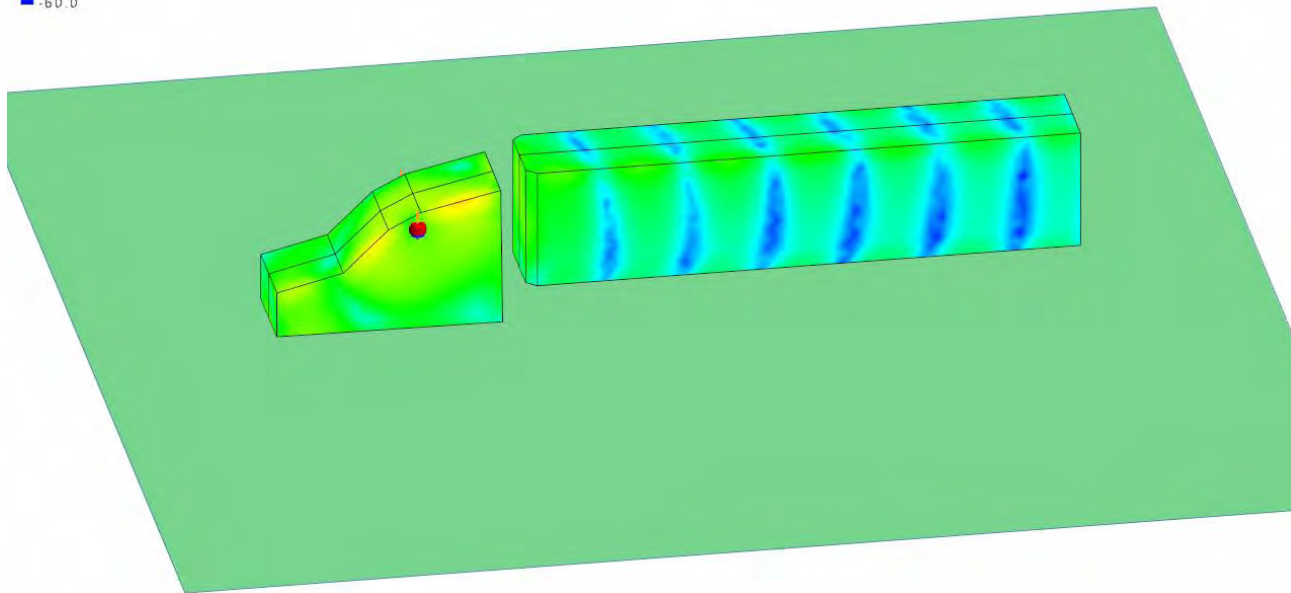


Peterbilt Semi 27 MHz

Currents 100 Watts

Surface current [dBA/m]

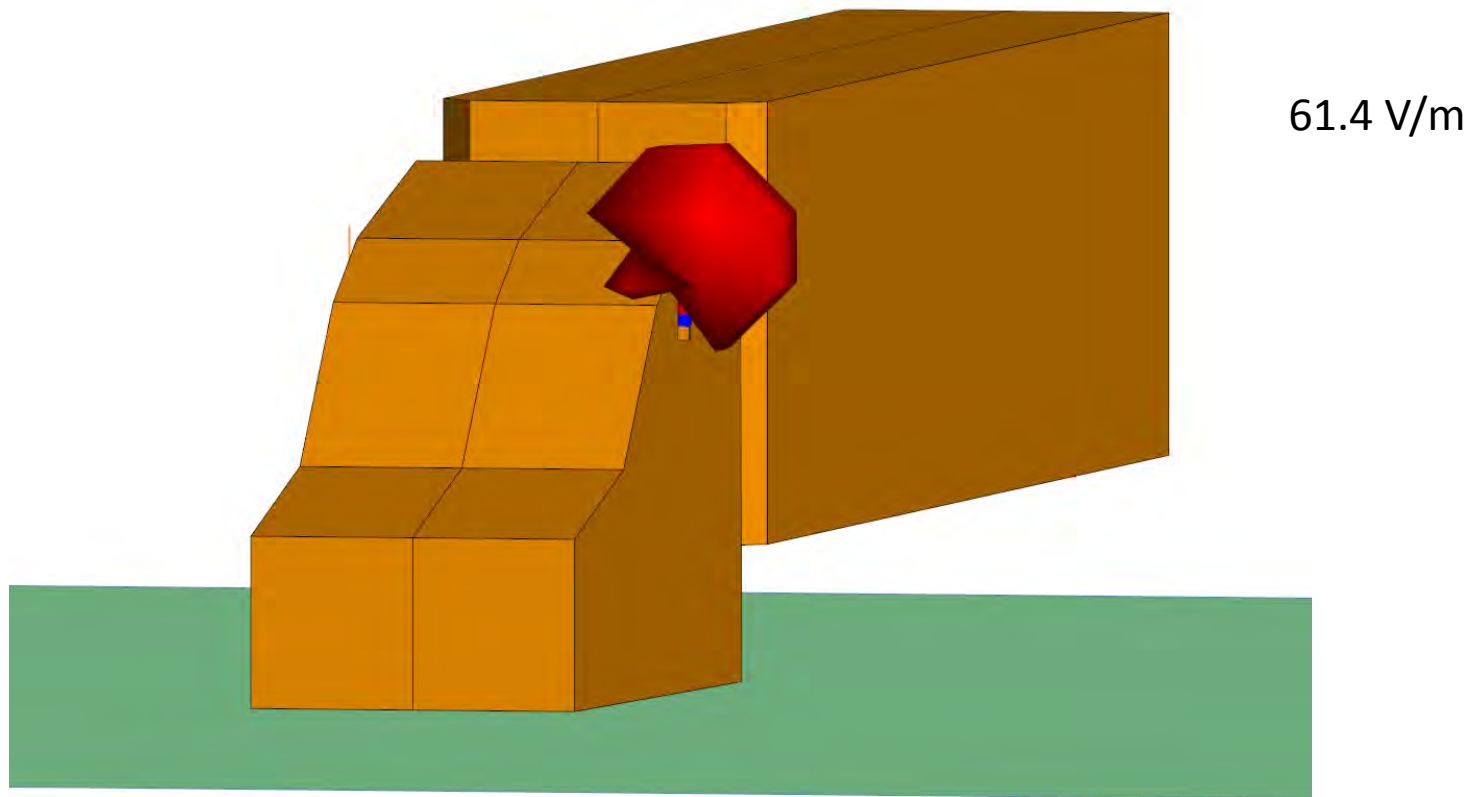
0.0
-6.0
-12.0
-18.0
-24.0
-30.0
-36.0
-42.0
-48.0
-54.0
-60.0



Phase = 271°

Peterbilt Semi

Near Field Antenna Pattern 100 Watts



Super King Air 200



Super King Air 200

CAD Model with Antenna

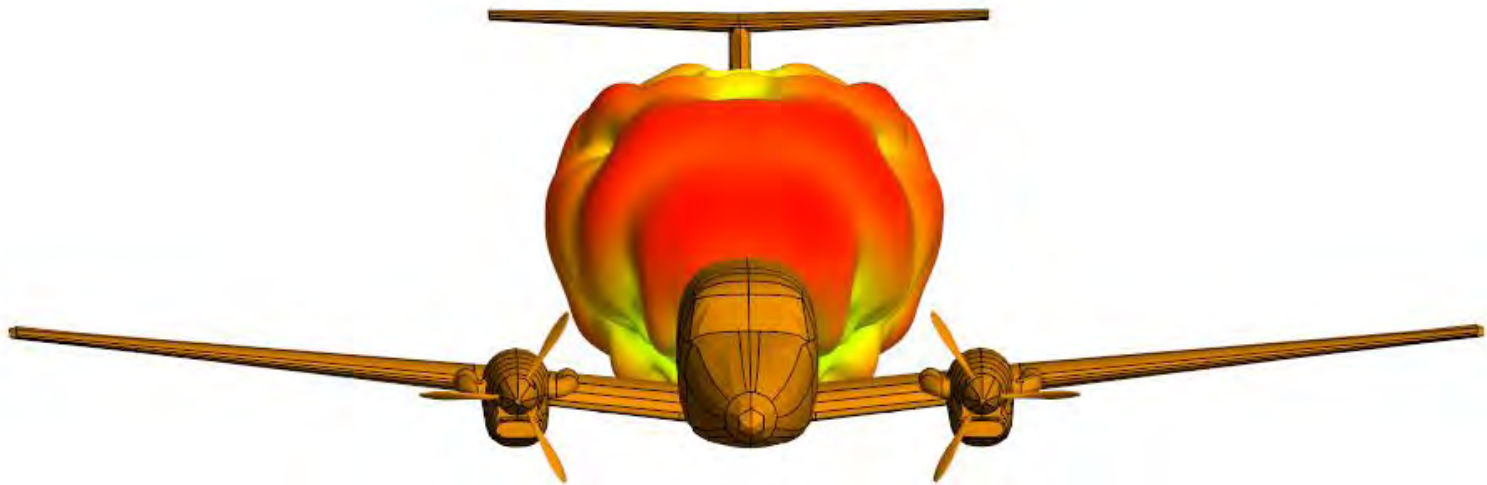
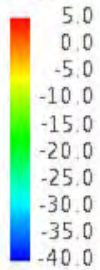


Number of Triangles = 22,683

Super King Air 200

Antenna Pattern 123.5 MHz

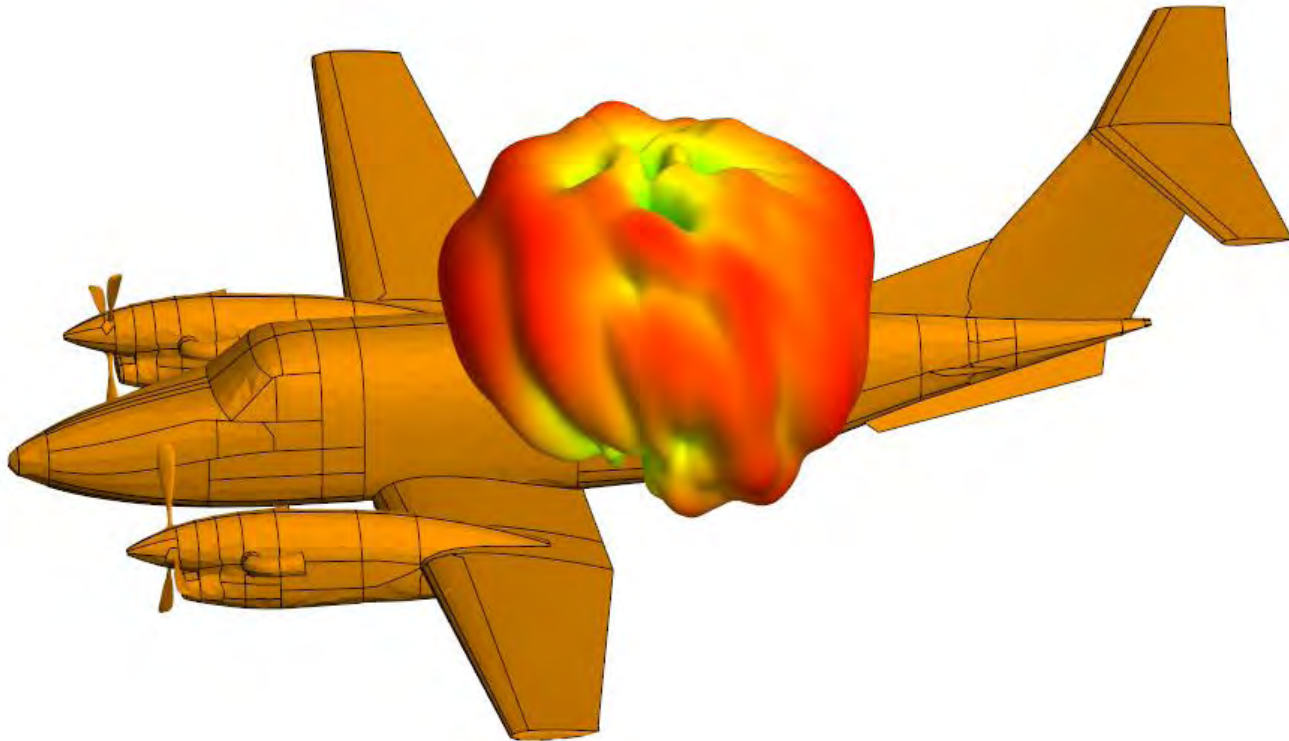
Total Gain [dBi]



Super King Air 200

Antenna Pattern 123.5 MHz

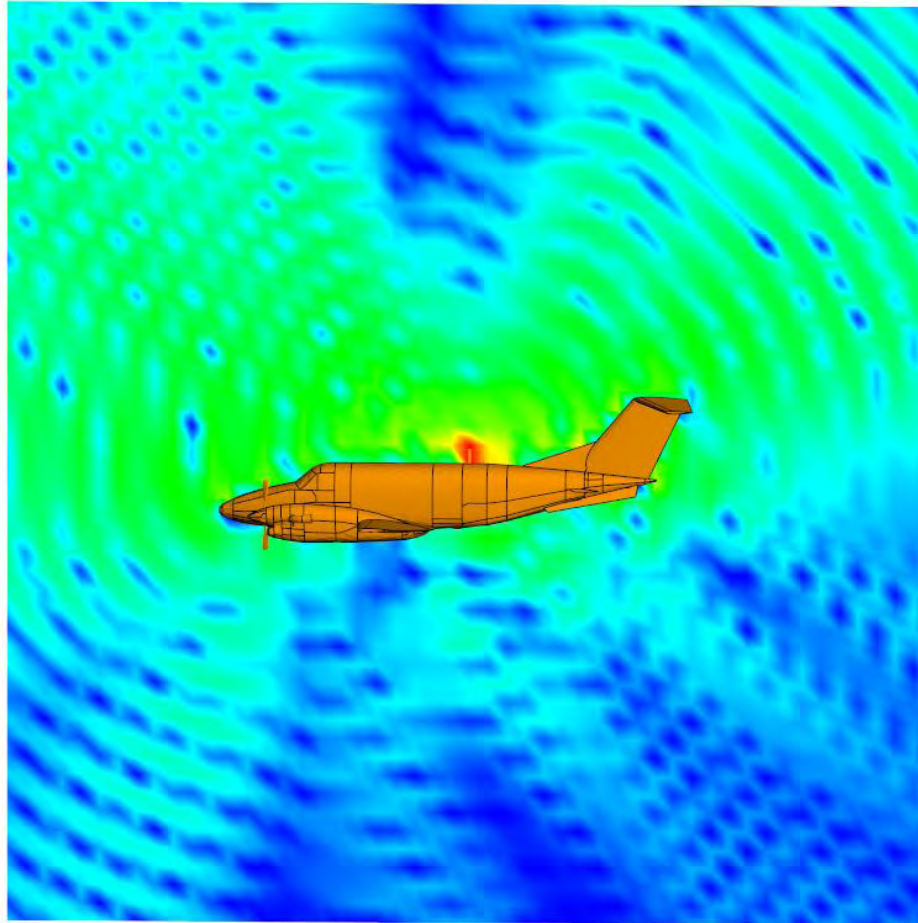
Total Gain [dBi]



Super King Air 200

Near Field Pattern 123.5 MHz

Instantaneous magnitude XYZ E-Field [dBV/m]

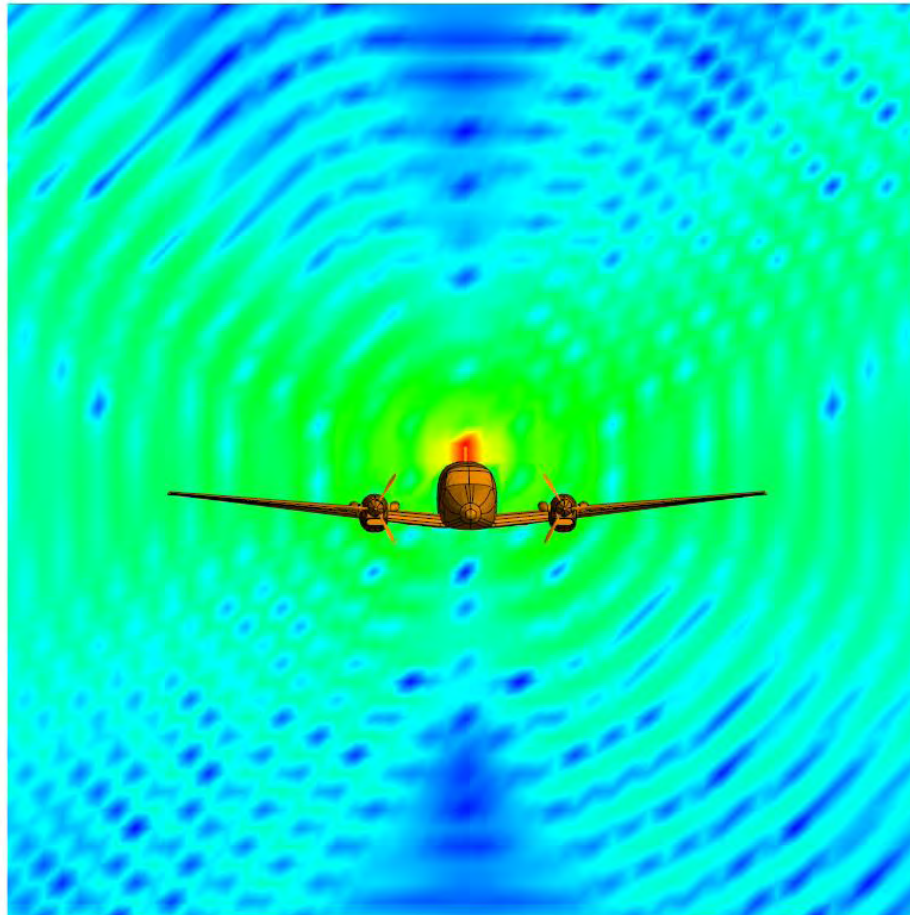
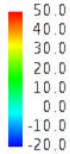


10 Watts

Super King Air 200

Near Field Pattern 123.5 MHz

Instantaneous magnitude XYZ E-Field [dBV/m]

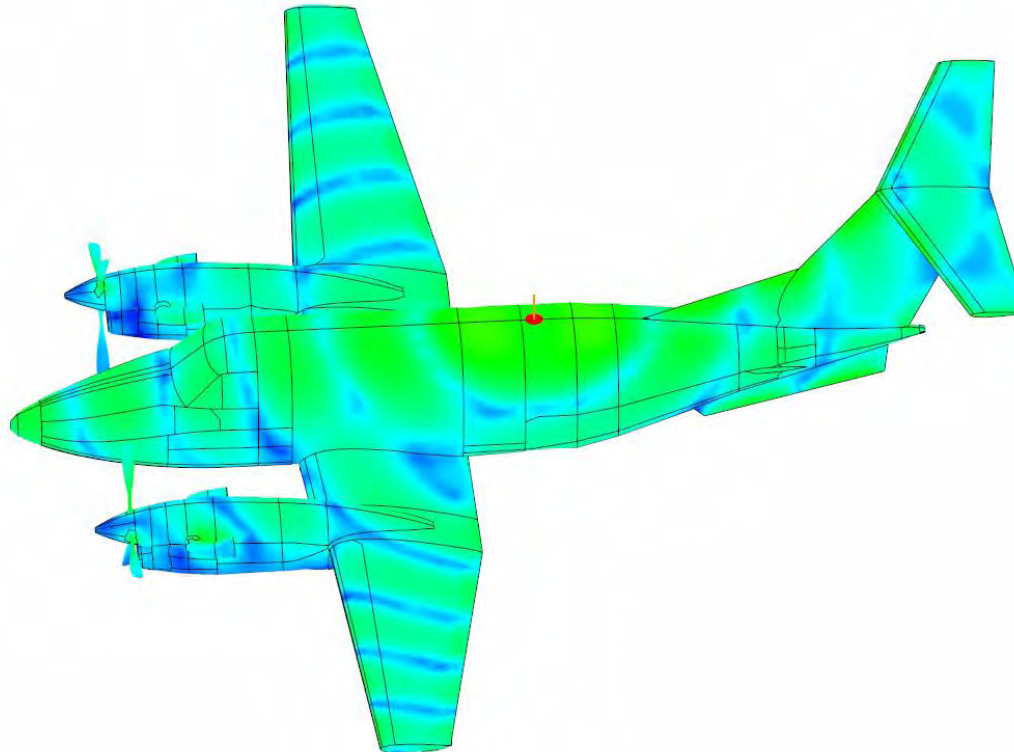


10 Watts

Super King Air 200

Currents 123.5 MHz

Surface current [dBA/m]



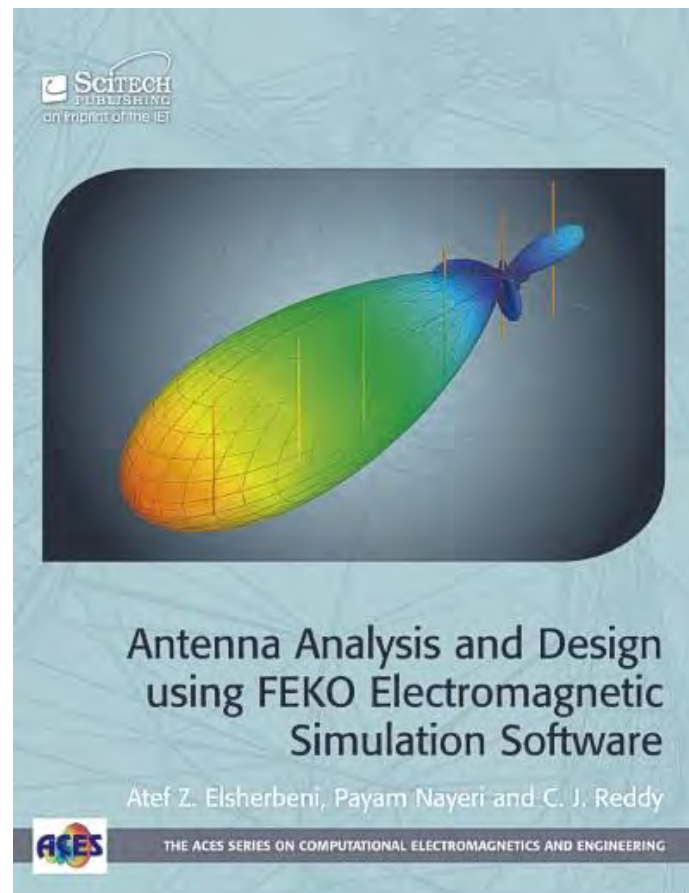
10 Watts

Conclusions

- With FEKO MoM and MLFMM one can quickly calculate antenna patterns on structures
- You can determine the correct place to install antennas on vehicles for optimum field of view
- You can calculate radiation hazards in 3 dimensions
- Or simply analyze the antenna on your roof

Further Reading

A.Z. Elsherbeni, P. Nayeri, and C.J. Reddy, *Antenna Analysis and Design Using FEKO Electromagnetic Simulation Software*, SciTech, 2014.



Also Possible with the Code Specific Absorption Rate Modeling

